ERP: A COMPUTERIZED GEO-INFORMATION DATA BANK FOR ENVIRONMENTAL RESOURCE PLANNING

by

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INTRODUCTION

INTRODUCTION

During the last two decades there has been a growing concern by the government and the public over the criteria and methods by which decisions about land use are made. An increase in environmental consciousness as well as a recognition of past misuses of our natural resources led Congress to pass the National Environmental Policy Act of 1970. It is the intention of the act "to encourage productive and enjoyable harmony between man and the environment; to provide efforts which will prevent or eliminate damage to the environment and biosphere and to stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the nation..."

The achievement of these lofty goals presents a difficult task. If concern about environmental quality is to act as a constraint on urban growth, then there is a need to develop and apply sensitive and thorough approaches to gauging the potential impacts of urbanization. One such approach is the use of computerized information storage and retrieval systems.

The application of computer technology has become an increasingly important facet of environmental planning. Several studies have been completed and many are underway which demonstrate the application of computerized information processing and data manipulation to environmental planning. The intention of this study is two-fold. First, to present a methodology of developing a computer based, geo-information data bank; and second, to develop a package program to display that information in the form of two-dimensional maps.

A geo-information data bank may be defined as a collection of information describing an area of the earth's surface. The condition which separates geographical information systems from other types is the requirement that the data be referenced in a manner that will allow retrieval, analysis, and display on spatial criteria. The system for processing this information is an organized set of steps or procedures, which accumulates, manipulates, and disseminates the information in such a way that it can be used as a basis for rational decision making. The system could be completely manual such as a collection of maps on which information is recorded, or it could consist of manual operations assisted by a computer with its associated hardware and software components which may be utilized to perform operations on the data base. Considering the myriad of interactive variables the planner must consider, it does not seem that a completely manual operation will continue to be practical. This is particularly true as computer usage becomes more and more available to local and regional planning agencies.

THE STUDY AREA

To demonstrate the application of a geo-information data system a study area of approximately 4 to 5 square miles has been selected. The approximate site location in relation to the state is shown in Figure 1. The location includes the City of Manhattan and its surrounding area. A more detailed delineation of the site is shown in Figure 2.

The site includes parts of two counties, Riley and Pottowatomie. It also includes two major rivers, the Kansas and the Blue, both have rather broad river valleys. Manhattan was originally settled at the confluence of the two rivers and most growth has occurred toward the upland area to the west. Recent trends in land development are toward the east into the river valley. With the construction of Tuttle Creek Reservoir on the Blue River flooding is no longer an eminent danger. However, many conflicting land uses have arisen. Urban expansion in the form of residential, commercial, and industrial land uses are competing for what is considered prime agricultural land. By means of a geo-information data system it may be possible to 1) measure in quantifiable terms the impact of expanding urban development, 2) determine the suitability of selected sites for development, and 3) to offer alternative locations for orderly growth and development.

The site is rectangular in shape and is a factor that was perhaps ill-considered. A project scale geo-information data bank, such as this, would be better defined by its natural watershed boundaries. A county, regional, or state data bank would be defined by its political boundaries which may or may not lie in a straight line.

STUDY AREA LOCATION

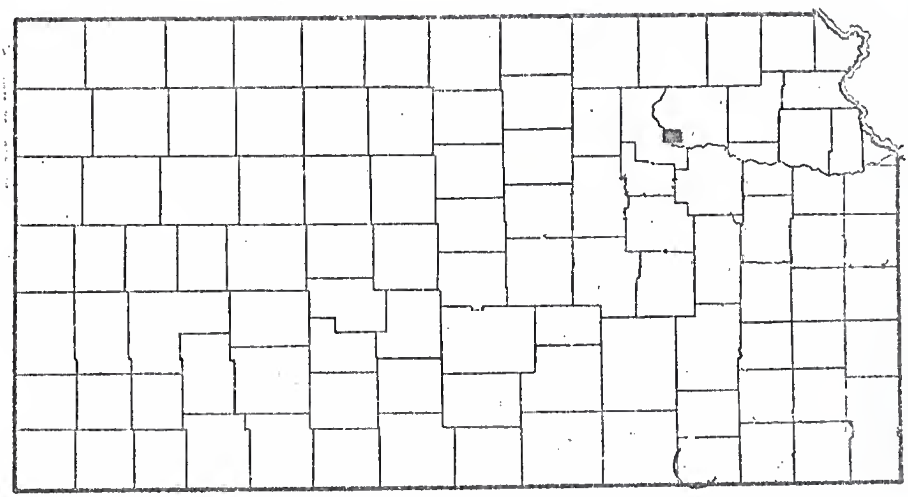


FIGURE 1 STATE MAP OF KANSAS ILLUSTRATING THE LOCATION OF THE STUDY AREA

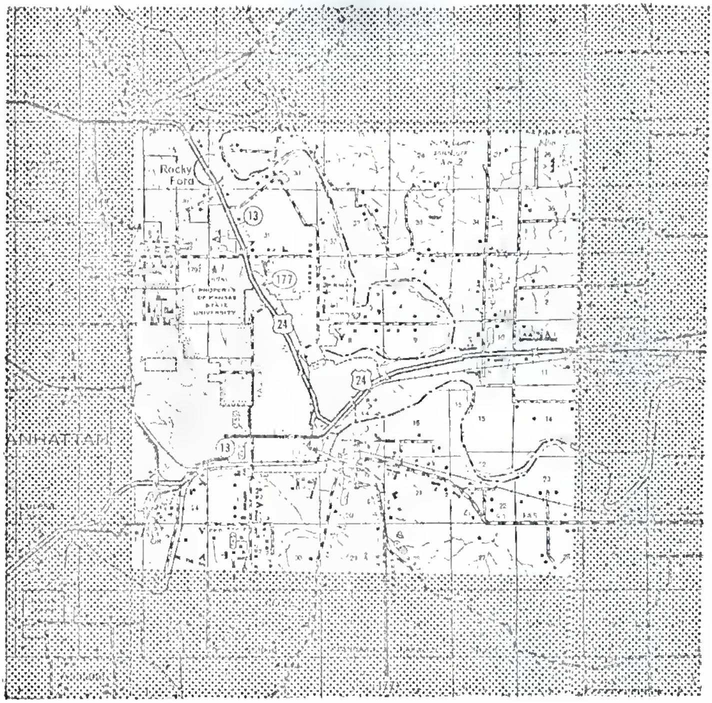


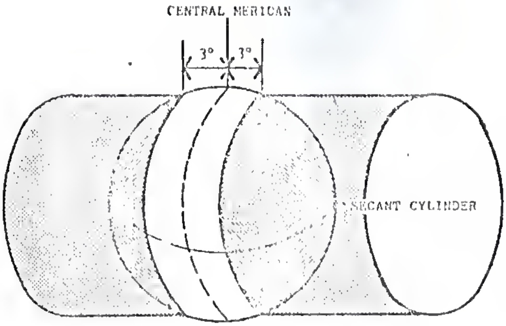
FIGURE 2 THE STUDY AREA

DATA REFERENCE SYSTEM

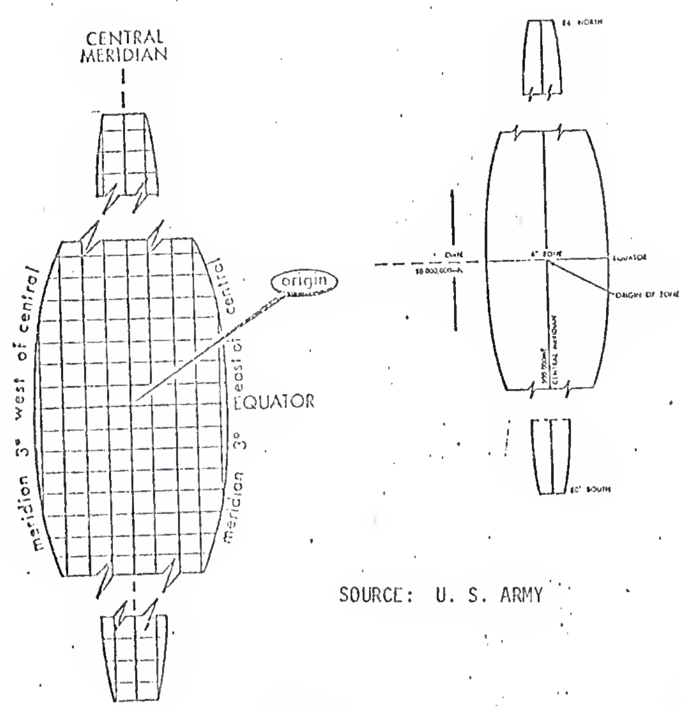
Data Reference System

By definition, information contained in a geo-information data bank must be spatailly related. That is, it must answer two questions: where is the location; and what are the geographic data. One solution to answering these questions is the use of the data cell system. The cell is the basic unit from which data is extracted. The Universal Transverse Mercator (UTM) grid is one system used to locate each cell.

The UTM system, developed by the U.S. Army, is a rectangular grid system designed for world use between 80° south and 80° north latitude. A rectangular grid is accomplished by mathematically projecting positions from the spheroidal shaped earth onto an imaginary cylinder which has its axis parallel to the plane of the equator and which intersects the earth in such a way that zones 6° in an east-west direction are created. There are 60 zones each 6° wide, created by 30 positions of the cylinder. A cylinder is a "developable" surface. That is, it can be rolled flat with no distortion so that a uniform grid can be formed. A line of longitude serves as the central meridian of a zone. Multiples of 6° longitude divide each zone. Divisions are made in a north-south direction by lines of latitude in multiples of 8°. Thus, quadrilaterals are created which are 6° east-west by 8° north-south and each of which is given a unique identification called the grid zone designation. Each of these zones is further divided into 100,000 meter squares each of which has a unique 2-letter designation. All recent USGS maps bear UTM grid ticks every 1,000 meters. Connecting these ticks will result in a grid of 1-kilometer squares. Because the basis of the USGS map is a polyconic projection the UTM grid may appear slightly askew.



TRANSVERSE MERCATOR PROJECTION



SOURCE: U. S. ARMY

FIGURE 3

The numerical value given to the grid lines is based on convenience. The arbitrary value for each central meridian within a zone is 500,000. The value for the equator is 0 for the northern hemisphere and 10,000,000 in the southern hemisphere. Thus a grid labled 4,351,000mN is 4,351,000 meters north of the equator and one labled 714,000mE is east of the central meridian by 214,000 meters.

The UTM system has provided the basis of the inventory grid from which cells of an appropriate size may be constructed. They may be one square mile, one square kilometer or some fraction thereof, one quarter, one sixteenth, etc. Cell size can be adjusted to fit the needs of the inventory. The selection of the cell size should be made with careful consideration of the data requirements. It appears to this researcher, that very small cell sizes will result in a high level of accuracy but at the cost of spending an inordinate amount of time extracting data; a task which becomes quite tedious over a long period of time. Consideration should also be given to the complexity of the study area. An urban area or a site of highly disected topography may require very small cell sizes (1-acre) while a large area of uniform topography and large open spaces may be adequately studied using relatively large cell sizes (1-kilometer squares).

Using the 1-kilometer UTM grid as the base, a cell size of 250 meters square was selected for the pilot study. This results in 16 cells for each square kilometer, an area equivalent to 6 hectares or approximately 15 acres. The data cells are identified by the numerical value given to the UTM grid lines with some modification for convenience. Because the maximum length of the study area is only 44 kilometers the first three digits and the last digit of the UTM grid number were

dropped resulting in a four digit number. Each cell is then numerically designated by the value of the grid lines below and left of the cell. The cell is then identified by an eight digit number. The first four digits represent the row number and the last four digits the column number.

The study area as delineated contains 1,760 cells on the basis of 16 cells per square kilometer. The reference system assumes a rectangular shape. However, irregular shaped areas may be delineated by assigning values of zero to cells outside the study area.

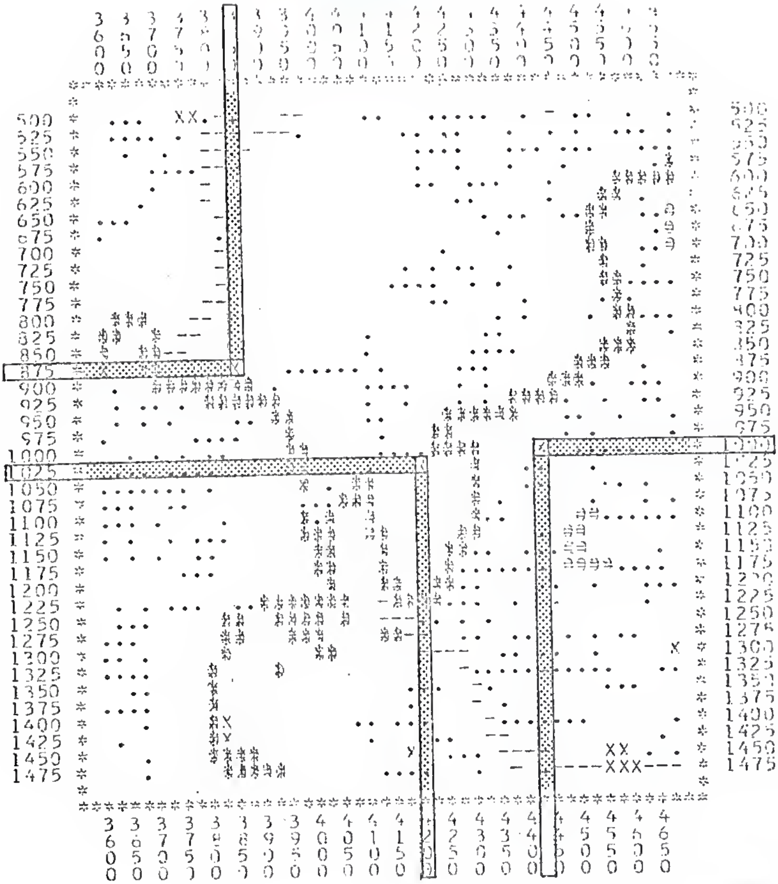


FIGURE 4 CELL IDENTIFICATION SYSTEM

Each cell has a specific identification number based upon the UTM grid system. The first four digits designate the row number and the last four digits designate the column number. The cells delineated in the above figure are 0875 3850, 1000 4425, 1025 4200.

VARIABLE LIST

Variable List Development

If the data bank is to provide a meaningful tool by which environmental planning decisions can be made then the system must be more accurate, more objective, and more comprehensive than systems used in the past. The initialization of such a system requires that careful attention be given to the development of the variable list which forms the basis of the data bank. The identification of resource variables is not a simple task. The initial listing of resource variables must be broad enough to insure coverage of all appropriate resource categories, it must be specific enough to provide for discrete analysis, and it must be flexible to provide for additional variables as more descriptive information becomes available.

For the purpose of this study a resource variable will be defined as a primary resource element or data type which is descriptive of some natural or cultural feature of the environment. An attribute is an inherent characteristic or quality of a specific resource variable. The following section examines that list of natural and cultural variables selected for the study area. The data processed includes physiographic, pedologic, hydrologic factors as well as man-made features and influences.

Natural Features

Sensible environmental planning should take into account such factors as drainage patterns, slope, elevation, and vegetative cover. Encroachment by man upon these ecologically fragile areas may result in significant disruptions to these natural systems. It is important that good land planning take into account the location of these natural resources and protect them from damage if possible.

Data relating to four natural features were included in the pilot study. They were as follows: 1) topographic elevation, 2) slope, 3) vegetative cover, and 4) surface water patterns. A discussion of the importance of each of these features follows.

Topographic Elevation

Topgraphic elevation is the measure in feet of the earth's height above some datum plane, usually mean sea level. Elevation helps define the climatic range within the study area as well as identifying flood prone areas. Vegetative associations vary with elevation in response to changed micro-climate, exposure and soil conditions.

In order to achieve greater flexibility than programs developed in the past it was decided not to predetermine the elevational levels within the study area. Rather, the data base should contain specific elevational information for each cell. The computer could then map the topographic relief within ten levels between the lowest elevation and the highest elevation. The centroid elevation of each cell was extracted and stored in the data bank for this purpose.

Slope

Slope may be defined as the degree to which a given stretch of land is inclined away from the horizontal. The formula used in calculating the slope (as a percent) may be expressed as the ratio of the change in vertical elevation to the horizontal distance along a straight line, times 100%. The importance of slope in land planning cannot be overestimated. Natural systems are disrupted by development practices which misuse land of various slopes. These misuses are major factors affecting soil erosion and surface runoff. Slope may be

regarded as one of the more critical determinates affecting development in urbanizing regions.

The selection of slope intervals is not an arbitrary decision. Appropriate criteria for the selection of slope intervals should relate to the geology and topography of the region under study, as well as the use to which the slope data will be put in the analysis phase. The Soil Conservation Service and the Agricultural Stabilization and Conservation Service generally use the following criteria for classifying slopes according to agricultural suitability.

0 - 5% slope	Low Limitation
5 - 10% slope	Moderate Limitation
10 - 15% slope	High Limitation
15%+ slope	Severe Limitation

Because of the abrupt changes in slope associated with the topography of the site and because the analysis phase is intended to include uses other than agriculture, a slightly modified classification system for this study was developed. The following attributes of the slope variable were selected:

Slope attributes	0 - 2%
	3 - 6%
	7 - 12%
	13 - 20%
	21%+

It should be noted that these attributes are not qualified as to the degree of suitability but may vary according to the analysis. For instance, in selecting sites where drainage is an important consideration, such as recreational areas, slopes of three to six percent would be more suitable than slopes of zero to two percent.

Vegetative Cover

Vegetative cover may be defined as the predominant plant life within a given area. The type, quality, and density of vegetative cover is an important consideration in good land planning. It is necessary to maintain good natural vegetation in some areas to provide maximum water infiltration and prevent soil erosion problems from developing. Woodlands servc as greenbelts that aid in controlling air and noise pollution. They also provide natural screening between different types of land use within an urban environment. Additionally, wooded sites provide habitat areas for wildlife as well as park and recreation facilities for an urban population.

The following classifications of vegetative cover were selected for the land use study.

Marshes

Prairie Grass

Shrubs

Lowland Forest

Upland Forest

Surface Water Patterns

Surface water patterns include streams, rivers, lakes, ponds, and all man-made water bodies. Knowledge of surface water patterns is essential to environmental planning. Development adjacent to drainage systems may drastically alter surface runoff which affects the stream composition, increases water pollution and has an exponential effect on higher order streams. Additionally, surface water provides wildlife habitats which need to be preserved. Larger lakes and rivers provide sites for hiking and camping. Surface water patterns identified in the

pilot study include:

Intermitent Stream

Creek

River

Lake or Pond less than 50 Acres

Lake or Pond greater than 50 Acres

The classifications of intermitent stream, creek, and river are used rather than a system of stream ordering because they are more readily identified on USGS maps. The distinction between lakes and ponds of less than 50 acres is the basic management guideline for the restriction in the use of power boats. It should be mentioned that although aguifer recharge areas were not included in this study they represent a critical element of the environment. Development on these ecologically fragile areas may drastically alter ground water and stream elevations as well as affecting the quality of our water resources.

Pedologic Features

Soils information plays a prominent role in the determination and classification of land for various purposes. It is generally agreed that there is a high correlation between certain soil types and agricultural productivity. Urbanization has added the need to examine soils for their suitability to septic tank locations, foundations for buildings as well as roads, sources of sand and gravel, and other developmental phenomena.

The soil classification system used in this study is that presented in the Pottowatomie-Riley Counties Water and Sewer Plan prepared by the Oblinger and Smith Corporation. The information

contained in the data bank pertaining to soils has been extracted from the Soil Structure Map contained in the above report. The following paragraphs contain a detailed discussion of the various land use classes and their capabilities.

Class 1

Lands in the class 1 category are those soils which are best suited to cultivation and require no special practices for erosion control and fertility maintenance. This class of land includes soils which are deep, friable, and silty to clayey. These soils are smooth and usually consist of well drained bottom lands. Also included in this group are the smooth and well drained stream terraces and second bottoms along the major streams and valleys of the study area. These areas usually include the best cropland and should not be compromised to the needs of expanding urbanization.

Class 2

Soils in the class 2 category are composed mostly of sandy soils. These well drained soils consist of alluvial deposits and range from 20 to 38 inches in depth. These soils are moderately fertile and suitable for continuous cultivation requiring only moderate agricultural practices for erosion control and fertility maintenance. Wind erosion may occur when the vegetative cover is removed. Of the 5 solid classes identified, this class is the most suitable for septic tank systems.

Class 3

Tight clay and claypan soils compose the major soil group in class 3. These soil types are generally found on slopes of three to five percent, which cause the surface soils to have less depth

(8 to 10 inches). The subsoils are composed of heavy clays to silty clay loams which extend to depths of 20 inches. The subsoil is sticky or plastic when wet and very hard when dry. Class 3 soils require intensive or complex agricultural practices to control sheet and gully erosion and to maintain fertility. These areas also have very low engineering capabilities.

Class 4

Class 4 soils consist of sandy soils, silty to clayey soils and tight clay and claypan soils. The topsoil layer is thin (8 to 10 inches) and the subsoil, which consists of silty clay to clay loam, extends to a depth of three feet. These soils are not suitable for continuous cultivation but may provide limited production of cultivated crops with extensive land management practices.

Class 5

Land areas in class 5 are typified by steep slopes, shallow, gravelly or stoney soils, severely eroded areas, loose sands, and frequently flooded or saline bottom lands. These soils have developed over limestone and limey shales generally on steep slopes of up to 14 percent. The topsoil is granular, silt loam to silty clay three to five inches thick. The subsoils seldom go deeper than sixteen inches. These areas are highly susceptible to erosion. They are unsuitable for cultivation but are suitable for grazing or woodland and limited development.

Cultural Features

The geo-information data bank should also contain data relating to the man-made influences upon the environment. Three cultural variables were selected for the study. They were as follows:

1) Activity Patterns, 2) Transportation and Utilities, and 3) Extrinsic Cultural or Historic Features. The following is a discussion of the importance of each of the identified features.

Activity Patterns

The activity patterns of the site identifies the utilization of the land by man. Potential imbalances created by human activities are reflected in present land use patterns, such as urban development in flood plain areas, encroachment on prime agricultural lands, and the visual pollution along transportation corridors. These misuses all impact on a variety of natural systems including wildlife, the soils system, and the hydrologic system. Good land use planning should insure a proper balance between man and nature.

In this study fourteen attributes relating to activity patterns were identified and extracted. They include:

- Residential
  - Rural (Agriculturally related housing)
  - Suburban (Low density, large lot sizes)
  - Urban (Medium to high density, fine grain)
  - Trailer Homes (Courts)
  - Vacation (Immediate access to recreational area)
- Commercial
- Industrial
- Agriculture
  - Cropland
  - Grazing Land

Recreation

State and Local Park

Golf Course

River and Lake Zoning

Institutional Land

Cemetaries

Transportation

Although transportation may be considered as a land use activity, for the purpose of this study it is considered a separate activity. The transportation network is one of the primary determinants of the direction of urban expansion. Residential, commercial, and industrial land uses are all linked directly to the accessibility of transportation. The location of existing and future transportation systems is related to a variety of natural features including slope, soil type, drainage patterns and vegetative cover as well as land use activities.

The following attributes relating to transportation systems within the site were identified.

1. Local Serving Street
2. Major Arterial
3. County Road
4. Unimproved Road
5. State Highway (2-lane)
6. State Highway (4-lane, divided)
7. Railway

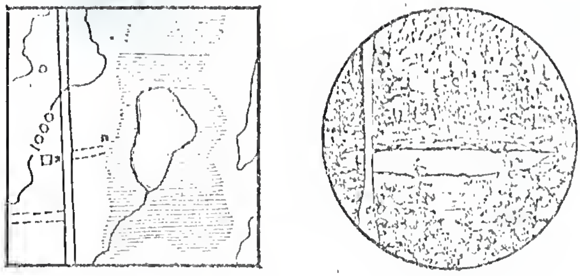
DATA EXTRACTION

Method of Extraction

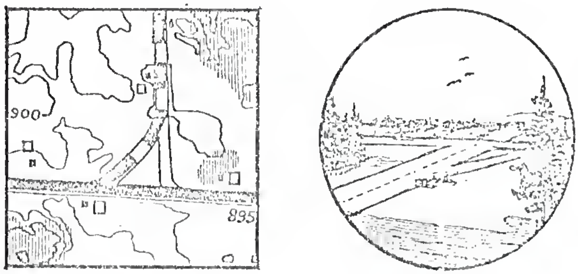
Having determined what variables are to be included in the inventory, the next consideration is the means by which the information will be obtained and stored in the data bank. It appears that there are four types of information that may be extracted. Data may be extracted by name, by percent coverage, by frequency or number per cell, or by presence or absence within each cell.

The method of extracting data from individual cells is dependent on the nature of the variable and the use to which the information is to be put. Specific natural and cultural variables were extracted as the percentage of cell that a particular attribute of a variable covers. By using this method the entire coverage of a cell may be stored in the data bank rather than only the dominate usage. In the case where more than one attribute is presented in a given cell, this system becomes much more discrete. Other features, such as transportation lines, were extracted on the basis of number per cell.

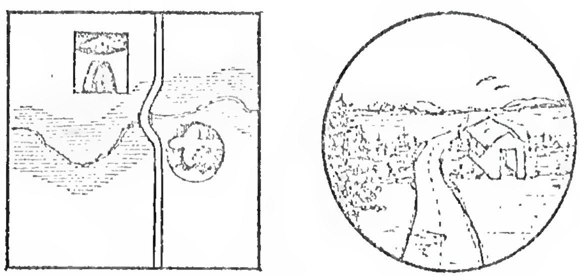
Finally, certain features or resources such as hydrologic resources were extracted by name (2-digit code) on the basis of their presence within a cell.



PERCENTAGE OF CELL
Hydrologic System
stream = 1%
lake = 6%



NUMBER PER CELL
Roadways
state hwy. = 1
county hwy. = 1



OCCURRENCE OF RESOURCE
covered bridge
waterfowl

Source: Miller, 1972

FIGURE 5

THE ERP SYSTEM

The Map Programs

The Environmental Resource Planning (ERP) package consists of four MAP programs written in PL1 . Each is designed to produce spatially related maps of variables that have been extracted using the cell system described previously. Each MAP program is designed to accept one of four types of data.

MAP1 is designed to accept four digit, integer data. It will produce a two-dimensional map in ten levels ranging from the lowest value to the highest value. Uses of the program include mapping topographic elevations which may include recording centroid elevation, lowest elevation, and/or highest elevation of each cell; mapping density characteristics such as number of dwelling units per cell; or descriptive characteristics such as average assessed valuation for each cell.

MAP2 is designed to accept data stored as a percentage of each cell. It can map up to fourteen attributes of any one variable. The program produces a set of two-dimensional maps (one for each attribute) illustrating the percentage of each cell occupied by the attribute. Percentages are mapped in ten levels between 0 and 99. Additionally it gives the frequency distribution of each level and the percentage of usage for each attribute over the entire site.

MAP 3 produces a two-dimensional map of up to ten attributes of a single variable which have been extracted on the basis of predominate type. That is the attribute which has the largest amount of coverage in a given cell. The attributes being extracted are assigned a coded value between 1 and 10. Each value is represented by an

overprint character on the computer printout. The program also has a provision for printing out the appropriate legend and the frequency distribution for each attribute.

MAP4 is designed to map data extracted according to the number of occurrences per cell. Unlike MAP1 this program does not require a data card for each cell, however, it will only accept integer values between 1 and 10. As many as 35 attributes of a variable may be stored in a single data file. The program will produce a set of two-dimensional maps (one for each attribute) illustrating the density pattern of each resource and the frequency distribution for each value.

In certain cases data that is extracted for use in one program can be converted for use in another program. For instance, Appendix B includes a program that will analyze a data deck in which a variable has been extracted by percent of cell and produce another data deck in which the information is converted to predominate type.

```
MAPI: PROCEDURE OPTICNS (MAIN);

/************************************************************************/
/*                                                                      */
/*      MAP1 IS A PRCGRAM DESIGNED TO MAP SPATIALLY RELATED INTERVAL   */
/* DATA.   IT IS MOST USEFUL IN MAPPING DENSITY PATTERNS OR CONTOUR     */
/* INTERVALS.  THE DATA WILL RANGE IN VALUE FROM A MINIMUM TO A         */
/* MAXIMUM IN UNIFORM INCREMENTS.  THE MINIMUM THAT MAY BE USED IS      */
/* ZERO AND THE MAXIMUM IS 9999.99.  THE USER MUST PROVIDE A NUMBIR     */
/* OF CARDS  IN THE SOURCE DECK.  THEY ARE:                             */
/*            IMAX = (NUMBER OF ROWS) ;                                 */
/*            JMAX = (NUMBER CF COLUMNS) ;                              */
/*            KMAX = (NUMBER OF VARIABLES TO BE MAPPED) ;               */
/*            CELL-NUMB = (TOTAL NUMBER OF CELL IN STUDY AREA);         */
/*            MIN(*) = (LOWEST VALUE OF EACH VARIABLE TO BE MAPPED) ;   */
/*            MAX(*) = (HIGHEST VALUE OF EACH VARIABLE TO BE MAPPED);   */
/*                                                                      */
/*      ADDITIONAL CARDS FOR PRINTING OUT APPROPRIATE LABELS MUST       */
/* ALSO BE SUPPLIED BY THE USER.  THE VARIABLE NAME 'TITLE' IS A        */
/* CHARACTER STRING OF 50 CHARACTERS USED TO IDENTIFY THE VARIABLE      */
/* NAME.  'LABEL(*)' IS A VARIABLE NAME  DESCRIBING THE SPECIEIC        */
/* ATTRIBUTE OF THE VARIABLE BEING MAPPED.  THERE IS ONE LABEL FOP      */
/* EACH ATTRIBUTE.  THE MAXIMUM LENGTH IS 100 CHARACTERS.               */
/* THE USER CARD SHOULD FOLLOW THE FORMAT BELOW:                        */
/*            TITLE = 'NAME OF VARIABLE';                               */
/*            LABEL(*) = 'NAME OF ATTRIBUTE';                           */
/* THE ASTERISK (*) REPRESENTS THE SEQUENTIAL NUMBER OF EACH            */
/* ATTRIBUTE.                                                           */
/*     THE USER MAY ALSO USE UP TO FIVE LINES ON THE COMPUTER           */
/* PRINTOUT TO PROVIDE INFORMATION PERTINENT TO HIS SPECIAL PROJECT     */
/* OR STUDY.  THE FIRST LINE MAY CONTAIN UP TO 100 CHARACTERS AND       */
/* THE REMAINING FOUR LINES CONTAIN 50 CHARACTERS EACH.  IF THE USER   */
/* DOES NOT WISH TO USE THE LINE OPTION HE MUST USE THE STATEMENT:      */
/*            LINE(1) = ' ';                                            */
/*                                                                      */
/************************************************************************/
DCL (MIN(1), MAX(1)) FIXED DEC (7,2);
DCL CELL_NUMB FIXED DEC;
DCL LINE(5) CHAR (50);
DCL TITLE CHAR (50);
DCL LABEL(14) CHAR (100);
/************************************************************************/

/* USER CARDS FOLLOW */

IMAX =
JMAX =
KMAX =
CELL_NUMB =
MIN(*) =              USER SUPPLIED INFORMATION
MAX(*) =
TITLE =
LABEL(*) =
LINE(*) =

/************************************************************************
BEGIN;
```

```
OPEN FILE (SYSPRINT) PAGESIZE(88);
   DCL MAP(IMAX,JMAX,KMAX) FIXED BIN;
   DCL NUMB(IMAX,JMAX,KMAX)  FIXED DEC (7,2);
   DCL (ROW(IMAX), COL(JMAX)) FIXED BIN;
   DCL LEVEL(KMAX,10) FIXED DEC;
   DCL (DIF, INCR) FIXED DEC;
   DCL FREQ(KMAX,10) FIXED DEC INITIAL ((KMAX*10)0);
   DCL PERCENT(10) FIXED DEC (7,2);

/* DETERMINE THE DIFFERENCE ('DIF') BETWEEN THE MIN(*) AND MAX(*)     */
/* VALUES AND DIVIDE BY 10.  THE RESULTANT IS THE INCREMENT ('INCR') */
/* BY WHICH THE DATA WILL BE MAPPED IN 10 LEVELS.                     */

   DO K = 1 TO KMAX;
      DIF = MAX(K) - MIN(K);
      INCR = DIF/10;
      LEVEL(K,1) = MIN(K) + INCR;
      DO N = 2 TO 10;
         LEVEL(K,N) = LEVEL(K,N-1) + INCR;
         END;
      END;

/* READ IN VALUES OF THE EXTRACTED DATA SO A MAP VALUE MAY BE         */
/* ASSIGNED FOR EACH CELL.                                            */

   DO I = 1 TO IMAX;
      DO J = 1 TO JMAX;
         GET EDIT (ROW(I), COL(J)) (COL(1), F(4), COL(6), F(4));
         DO K = 1 TO KMAX;
            GET EDIT (NUMB(I,J,K))(F(4,0));    /***CHANGE***/
           DO N = 1 TO 10;
               IF NUMB(I,J,K) <= LEVEL(K,N) THEN DO;
                  MAP(I,J,K) = N;
                  FREQ(K,N) = FREQ(K,N) + 1;
                  GO TO MATCH;
                  END;
               END;
MATCH:      END;          /*  K LOOP  */
         END;      /*  J LOOP  */
      END;      /*  I LOOP  */

/* AFTER ALL THE DATA HAS BEEN TRANSFORMED TO MAP VALUES OVERPRINT    */
/* CHARACTERS ARE ASSIGNED TO EACH VALUE TO DISPLAY THE MAP PRINTOUT */

/*******************************************************************/

DCL SYM(10) CHAR(1);
      SYM(1)='.';
      SYM(2)='|';
      SYM(3)='-';
      SYM(4)='+';
      SYM(5)='X';
      SYM(6)='O';
      SYM(7)='=';
      SYM(8)='|';
      SYM(9)='X';
      SYM(10)='#';
```

```
DCL ARRAY(4,JMAX) FIXED BIN INITIAL ((4*JMAX)0);
   DCL (ITEMP,NFIX(4)) FIXED BIN;

   DO N = 1 TO JMAX BY 2;
      ITEMP = COL(N);
      DO I = 1 TO 3;
         NFIX(I) = ITEMP/10**(4-I);
         ITEMP = ITEMP-(NFIX(I)*10**(4-I));
         ARRAY(I,N) = NFIX(I);
         END;
      ARRAY(4,N) = ITEMP;
      END;

/*********************************************************************/

   DO K = 1 TO KMAX;
      PUT EDIT (TITLE) (A(50));
      DO M = 1 TO 4;
         PUT SKIP EDIT (' ') (COL(6), A(1));
         DO N = 1 TO JMAX BY 2;
            PUT EDIT (ARRAY(M,N)) (F(2));
            END;
         END;
      PUT EDIT (('*' DO I = 6 TO JMAX+9)) (COL(I), A(1));
      PUT EDIT ('*', '*') (COL(6), A(I), COL(JMAX+9), A(I));
      DO I = 1 TO IMAX;
         PUT EDIT (ROW(I), '*') (COL(1), F(4), X(1), A(1));
         DO J = 1 TO JMAX;
            IF MAP(I,J,K) > 5 THEN DO;
               PUT EDIT (SYM(6)) (COL(J+7), A(1));
               END;
            DO N = 1 TO 5;
               IF MAP(I,J,K) = N THEN DO;
                    PUT EDIT (SYM(N)) (COL(J+7), A(1));
                    END;
                END;
            END;
         PUT SKIP(0);
         DO N = 7 TO 10;
            DO J = 1 TO JMAX;
               IF MAP(I,J,K) >= N THEN DO;
                    PUT EDIT (SYM(N)) (COL(J+7), A(1));
                    END;
                END;
            PUT SKIP(0);
            END;
         PUT EDIT (' * ', ROW(I)) (COL(JMAX+8), A(3), F(4));
         END;
      PUT EDIT ('*', '*') (COL(6), A(1), COL(JMAX+9), A(1));
      PUT EDIT (('*' DO I = 6 TO JMAX+9)) (COL(I), A(I));
      DO M = 1 TO 4;
         PUT SKIP EDIT (' ') (COL(6), A(1));
         DO N = 1 TO JMAX BY 2;
            PUT EDIT (ARRAY(M,N)) (F(2));
            END;
         END;
```

```
/* THE REMAINING PORTION OF THE PROGRAM PRINTS THE LEGEND AND          */
/* OTHER INFORMATION PROVIDED BY THE USER BELOW THE MAP.               */

   PUT SKIP(2) EDIT (LABEL(K)) (A(100));
   IF LINE(1)¬= ' ' THEN DO;
   PUT SKIP(2);
      PUT EDIT (LINE(1)) (A(100));
      DO N = 2 TO 5;
         PUT EDIT (LINE(N)) (COL(50), A(50));
         END;
      END;
      PUT SKIP(3) EDIT ('DATA MAPPED IN 10 LEVELS FROM THE MINIMUM VALU
E', MIN(K), 'TO THE HIGHEST VALUE', MAX(K)) (A(47), F(7,2), X(1),
A(22), F(7,2));
      PUT SKIP(3) EDIT ('VALUE RANGE APPLYING TO EACH CELL') (A(60));
      PUT EDIT ('MINIMUM', MIN(K)) (COL(2), A(10), COL(21), F(7,2));
      DO N = 1 TO 9;
         PUT EDIT (LEVEL(K,N)+.01) (X(3), F(7,2));
         END;
      PUT EDIT ('MAXIMUM') (COL(2), A(16));
      DO N = 1 TO 10;
         PUT EDIT (LEVEL(K,N)) (X(3), F(7,2));
         END;
   PUT SKIP(2) EDIT ('PERCENTAGE OF STUDY AREA INCLUDED AT EACH LEVEL')
      (A(100));
   PUT SKIP EDIT (' ') (COL(17), A(1));
   DO N = 1 TO 10;
      PERCENT(N) = (FREQ(K,N)/CELL_NUMB)*100;
      PUT EDIT (PERCENT(N)) (X(4), F(6,2));
      END;
   PUT SKIP(2) EDIT ('FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EAC
H LEVEL') (A(100));
   PUT SKIP(2) EDIT ('LEVELS        0') (X(1), A(14));
   DO NLEVEL = 1 TO 10;
     PUT EDIT (NLEVEL) (X(8), F(2));
     END;
   PUT SKIP(1);
   PUT EDIT (('=' DO I = 10 TO 120)) (COL(I), A(1));
   DO X = 1 TO 5;
     IF X = 3 THEN
     DO;
        PUT SKIP EDIT ('SYMBOLS') (X(1), A(7));
        END;
     ELSE DO;
        PUT SKIP;
        END;
     PUT EDIT ('......... IIIIIIIII --------- +++++++++ XXXXXXXXX 0000
0000 000000000 000000000 000000000 000000000') (COL(21), A(100));
     PUT SKIP (0);
     PUT EDIT ('========= ========= ========= =========') (COL(81),
        A(40));
     PUT SKIP (0);
     PUT EDIT ('IIIIIIIII IIIIIIIII IIIIIIIII') (COL(91), A(30));
     PUT SKIP (0);
     PUT EDIT ('XXXXXXXXX XXXXXXXXX') (COL (101), A(20));
     PUT SKIP (0);
```

```
      PUT ECIT ('##########') (COL(111), A(10));
      END;
    PUT SKIP;
    PUT EDIT (('=' DO I = 10 TO 120)) (COL(I), A(1));
    PUT EDIT ('FREQUENCY') (COL(2), A(16));
       DO N = 1 TO 10;
          PUT ECIT (FREQ(K,N)) (X(4), F(6));
          END:
       END;          /*  K LCOP  */
END;       /* BEGIN BLCCK  */
END MAP1;
```

```
MAP2: PROCEDURE OPTIONS (MAIN);

/* SITEMAP II                         BY THOMAS M. KUNTZ                  */
/*                                       DEPT. OF REG. & COMM. PLANNING */
/*                                       KANSAS STATE UNIVERSITY         */

/**************************************************************************/
/*                                                                        */
/*     MAP2 IS A SPECIALIZED PROGRAM OF THE SITEMAP II PACKAGE AND        */
/* IS DESIGNED TO MAP SPATIALLY RELATED DATA THAT IS EXTRACTED AS A      */
/* PERCENT OF EACH CELL.  THE DATA MAY RANGE IN VALUE FROM ZERO TO       */
/* 1.00.  AS MANY AS 14 ATTRIBUTES OF EACH VARIABLE MAY BE MAPPED.       */
/* THE FOLLOWING CARDS ARE REQUIRED BY THE USER TO ESTABLISH THE         */
/* BOUNDARIES OF THE SITE OR STUDY AREA.                                  */
/*              IMAX = (NUMBER OF ROWS);                                  */
/*              JMAX = (NUMBER OF COLUMNS);                               */
/*              KMAX = (NUMBER OF ATTRIBUTES FOR VARIABLE);               */
/*              CELL_NUMB = (TOTAL NUMBER OF CELL IN STUDY AREA);         */
/*                                                                        */
/*     ADDITIONAL CARDS FOR PRINTING OUT APPROPRIATE TITLES AND           */
/* LEGEND MUST ALSO BE SUPPLIED BY THE USER.  THE VARIABLE NAME           */
/* 'TITLE' IS A CHARACTER STRING OF 50 CHARACTERS USED TO IDENTIFY        */
/* THE VARIABLE NAME.  'LABEL(*)' IS A VARIABLE NAME DESCRIBING THE       */
/* SPECIFIC ATTRIBUTE BEING MAPPED.  THERE IS ONE LABEL CARD FOR          */
/* EACH ATTRIBUTE (MAXIMUM IS 14) AND THE LABEL IS LIMITED TO 100         */
/* CHARACTERS.                                                            */
/*              TITLE = 'NAME OF VARIABLE';                               */
/*              LABEL(*) = 'NAME OF ATTRIBUTE';                           */
/* THE  ASTERISK REPRESENTS THE SEQUENTIAL NUMBER OF EACH VARIABLE       */
/* ATTRIBUTE.                                                             */
/*     THE USER MAY ALSO USE UP TO FIVE LINES ON THE COMPUTER             */
/* PRINTOUT TO PROVIDE INFORMATION PERTINENT TO HIS SPECIAL PROJECT      */
/* OR STUDY.  THE FIRST LINE MAY CONTAIN UP TO 100 CHARACTERS AND         */
/* THE REMAINING FOUR LINES CONTAIN 50 CHARACTERS EACH.  IF THE USER     */
/* DOES NOT WISH TO USE THE LINE OPTION HE MUST USE THE STATEMENT:        */
/*              LINE(1) = ' ';                                            */
/*                                                                        */
/**************************************************************************/
DCL(IMAX, JMAX, KMAX) FIXED BIN;
DCL CELL_NUMB FIXED BIN;
DCL TITLE CHAR (50);
DCL LABEL(14) CHAR (100);
DCL LINE(5) CHAR (100);
/**************************************************************************/

/* USER CARDS FOLLOW */

IMAX =
JMAX =
KMAX =
CELL_NUMB =          /* USER SUPPLIED INFORMATION */
TITLE =
LABEL(*) =
LINE(*) =

/**************************************************************************/
```

```
BEGIN;
OPEN FILE (SYSPRINT) PAGESIZE(160);
   DCL ATTR(KMAX) FIXED DEC(5,2);
   DCL (ROW(IMAX), COL(JMAX)) FIXED BIN;
   DCL MAP(IMAX,JMAX,KMAX) FIXED DEC(5,2);
   DCL REMAP(IMAX,JMAX,KMAX) FIXED BIN;
   DCL FREQ(KMAX,11) FIXED BIN INITIAL ((KMAX*11)0);
   DCL PERCENT(KMAX) FIXED DEC (10,2) INITIAL ((KMAX)0);
   DCL JUMP CHAR (1);

/* INPUT DATA AND ASSIGN VALUE TO MAP(I,J,K)                                  */

   DO I = 1 TO IMAX;
      DO J = 1 TO JMAX;
         GET EDIT (ROW(I), COL(J), JUMP) (COL(1), F(4), X(1), F(4),
            A(1));
         DO K = 1 TO KMAX;
            GET EDIT (ATTR(K)) (F(5,2));
            MAP(I,J,K) = ATTR(K);
            PERCENT(K)=PERCENT(K)+ATTR(K);

/* REASSIGN CORRESPONDING VALUE TO REMAP(I,J,K)                               */

            ADDER = 0;              /* MAP VALUE COUNTER */
            KOUNT = 0;               /* REMAP VALUE COUNTER */
            IF MAP(I,J,K) = ADDER THEN DO;
               REMAP(I,J,K) = KOUNT;
               FREQ(K,KOUNT+1) = FREQ(K,KOUNT+1)+1;
               GO TO FIND;
               END;
SEEK:       ADDER = ADDER + 0.10;
            KOUNT = KOUNT + 1;
            IF MAP(I,J,K) <= ADDER THEN DO;
               REMAP(I,J,K) = KOUNT;
               FREQ(K,KOUNT+1) = FREQ(K,KOUNT+1)+1;
               GO TO FIND;
               END;
            IF ADDER ¬= 1.00 THEN GO TO SEEK;
FIND:       END;
         END;
      END;

/*************************************************************************/
/*      AFTER ALL THE EXTRACTED DATA VALUES HAVE BEEN CONVERTED TO       */
/* REMAP VALUES A SPATIALLY RELATED MAP USING CHARACTER SYMBOLS IS       */
/* PRINTED OUT.  THE FOLLOWING CHARACTER SYMBOLS ARE USED:               */
/*************************************************************************/

   DCL SYM(10) CHAR(1);
   SYM(1)='.';
   SYM(2)='|';
   SYM(3)='-';
   SYM(4)='+';
   SYM(5)='X';
   SYM(6)='0';
   SYM(7)='=';
   SYM(8)='|';
```

```
   SYM(9)='X';
   SYM(10)='#';

/* ARRAY(*,*) IS A TEMPORARY STORAGE SPACE TO ALLOW THE UTM GRID      */
/* NUMBERS USED FOR COLUMN REFERENCE POINTS TO BE PRINTED VERTICALLY */

   DCL ARRAY (4,JMAX) FIXED BIN INITIAL ((4*JMAX)0);
   DCL (ITEMP, NFIX(4)) FIXED BIN;

   DO N = 1 TO JMAX BY 2;
      ITEMP = COL(N);
      DO I = 1 TO 3;
         NFIX(I) = ITEMP/10**(4-I);
         ITEMP = ITEMP-(NFIX(I)*10**(4-I));
         ARRAY(I,N) = NFIX(I);
         END;
      ARRAY(4,N) = ITEMP;
      END;

/* BEGIN PRINTING OUT MAP PICTURE       */

   DO K = 1 TO KMAX;
         PUT EDIT (TITLE) (A(50));
      PUT SKIP(1);
      DO M = 1 TO 4;
         PUT SKIP EDIT (' ') (COL(6), A(1));
         DO N = 1 TO JMAX BY 2;
            PUT EDIT (ARRAY(M,N)) (F(2));
            END;
         END;
      PUT EDIT (('*' DO I = 6 TO JMAX + 9)) (COL(I), A(1)I;
      PUT EDIT ('*', '*') (COL(6), A(1), COL(JMAX+9), A(1));
      DO  I = 1 TO IMAX;
         PUT EDIT (ROW(I), '*') (COL(1), F(4), X(1),A(1));
         DO J = 1 TO JMAX;
            IF REMAP(I,J,K) > 5 THEN DO;
               PUT EDIT (SYM(6)) (COL(J+7), A(1));
               END;
            ELSE DO;
               DO N = 1 TO 5;
                  IF REMAP(I,J,K)  = N THEN DO;
                     PUT EDIT (SYM(N)) (COL(J+7), A(1));
                     END;
                  END;
               END;
            END;
         PUT SKIP(0);
         DO N = 7 TO 10;
            DO J = 1 TO JMAX;
               IF REMAP(I,J,K) >= N THEN DO;
                  PUT EDIT (SYM(N)) (COL(J+7), A(1));
                  END;
               END;
            PUT SKIP(0);
            END;
         PUT EDIT (' * ', ROW(I)) (COL(JMAX+8), A(3), F(4));
         END;
```

```
      PUT EDIT ('*', '*') (COL(6), A(1), COL(JMAX+9), A(1));
      PUT EDIT (('*' DO I = 6 TO JMAX+9)) (COL(I), A(1));
      DO M = 1 TO 4;
         PUT SKIP EDIT (' ') (COL(6), A(1));
         DO N = 1 TO JMAX BY 2;
            PUT EDIT (ARRAY(M,N)) (F(2));
            END;
         END;

/* THE REMAINING PORTION OF THE PROGRAM UTILIZES THE USER             */
/* SUPPLIED INFORMATION TO LABEL THE MAP AND PROVIDE THE APPROPRIATE */
/* LEGEND.                                                            */

      PUT SKIP(2) EDIT (LABEL(K)) (A(100));
      PUT SKIP(2);
      IF LINE(1) ¬= ' ' THEN DO;
         PUT EDIT (LINE(1)) (A(100));
         DO N = 2 TO 5;
            PUT EDIT (LINE(N)) (COL(50), A(50));
            END;
         END;
      PUT SKIP(3) EDIT ('DATA IS EXTRACTED AS A PERCENT OF EACH CELL AN
D') (A(100));
      PUT SKIP EDIT ('MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.0
0 AND 100.00 PERCENT') (A(100));
      PUT SKIP(3) EDIT ('VALUE RANGE APPLYING TO EACH LEVEL') (A(100));
      DCL (MIN, MAX) FIXED DEC (6,2);
      MIN = 0.01;
      MAX = 100.00;
      ADDER = MIN;
      PUT EDIT ('MINIMUM', MIN) (COL(2), A(10), COL(22), F(6,2));
ADD1: ADDER = ADDER + 10.00;
      IF ADDER < MAX THEN DO;
         PUT EDIT (ADDER) (X(4), F(6,2));
         GO TO ADD1;
         END;

      PUT EDIT ('MAXIMUM') (COL(2), A(16));
      ADDER = 0;
ADD2: ADDER = ADDER + 10.00;
      PUT EDIT (ADDER) (X(4), F(6,2));
      IF ADDER < MAX THEN GO TO ADD2;

/* CALCULATE PERCENTAGE OF TOTAL SITE IN WHICH RESOURCE IS PRESENT   */

   DCL PERCENT_TOT FIXED DEC (6,2);
   PERCENT_TOT = (PERCENT(K)/CELL_NUMB)*100;
   PUT SKIP(2) EDIT ('TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRE
SENT EQUALS', PERCENT_TOT) (A(61), F(6,2));

/* PRINT OUT FREQUENCY DISTRIBUTION                                   */

   PUT SKIP(2) EDIT ('FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EAC
H LEVEL') (A(100));
   PUT SKIP(2) EDIT ('LEVELS       0') (X(1), A(14));
   DO NLEVEL = 1 TO 10;
     PUT EDIT (NLEVEL) (X(8), F(2));
```

```
      END;
   PUT SKIP(1);
   PUT EDIT (('=' DO I = 10 TO 120)) (COL(I), A(1));
   DO X = 1 TO 5;
      IF X = 3 THEN
      DO;
         PUT SKIP EDIT ('SYMBOLS') (X(1), A(7));
         END;
      ELSE DO;
         PUT SKIP;
         END;
      PUT EDIT ('.......... ||||||||| --------- +++++++++ XXXXXXXXX 00000
0C00 GOCCCCOCO COOOCCC00 COC000000 000000000') (COL(21), A(100));
      PUT SKIP (0);
      PUT EDIT ('========= ========= ========= =========') (COL(81),
         A(40));
      PUT SKIP (0);
      PUT EDIT ('||||||||| ||||||||| |||||||||') (COL(91), A(30));
      PUT SKIP (0);
      PUT EDIT ('XXXXXXXXX XXXXXXXXX') (COL (101), A(20));
      PUT SKIP (0);
      PUT EDIT ('#########') (COL(111), A(10));
      END;
   PUT SKIP;
   PUT EDIT (('=' DO I = 10 TO 120)) (COL(I), A(1));
      PUT EDIT ('FREQUENCY') (COL(2), A(9));
      PUT EDIT (FREQ(K,1)) (F(6));
      DO N = 2 TO 11;
         PUT EDIT (FREQ(K,N)) (X(4), F(6));
         END;
      PUT PAGE;
      END;
   END;        /*  BEGIN BLOCK  */
END MAP2;
```

```
MAP3: PROCEDURE OPTIONS (MAIN);

/* ERP - MAP3                BY THOMAS M. KUNTZ                              */
/*                              DEPT. OF REGIONAL & COMMUNITY PLANNING        */
/*                              KANSAS STATE UNIVERSITY                       */
/***************************************************************************/
/*                                                                           */
/*                                                                           */
/*    MAP3 IS A SPECIALIZED  PROGRAM OF THE ERP PACKAGE AND IS               */
/* DESIGNED TO MAP VARIABLES THAT ARE EXTRACTED BY OCCURENCE.  IT            */
/* PRODUCES A SPATIALLY RELATED, TWO DIMENSIONAL MAP INDICATING THE          */
/* CELLS IN WHICH DATA IS PRESENT.  THE USER MAY MAP UP TO TEN               */
/* ATTRIBUTES OF A SINGLE VARIABLE.  THE FOLLOWING CARDS ARE                 */
/* REQUIRED BY THE USER TO ESTABLISH THE BOUNDARIES OF THE SITE.             */
/*              IMAX = (NUMBER OF ROWS);                                     */
/*              JMAX = (NUMBER OF COLUMNS);                                  */
/* THE USER MUST ALSO PROVIDE THE REFERENCE NUMBER OF UPPER LEFT             */
/* CELL.(NOTE - THIS CELL MUST HAVE THE LOWEST ROW AND COLUMN VALUE).*/
/* THE USER MUST ALSO PROVIDE THE INCREMENTAL DIFFERENCE  BETWEEN            */
/* GRID LINES.                                                               */
/*              IAXIS = (ROW NUMBER OF UPPER LEFT CELL);                     */
/*              JAXIS = (COLUMN NUMBER OF UPPER LEFT CELL);                  */
/*              INCREMENT = (INCREMENTAL DIFF. BETWEEN GRID LINES);          */
/*                                                                           */
/*    ADDITIONAL CARDS FOR PRINTING OUT APPROPRIATE TITLES AND A             */
/* LEGEND MUST ALSO BE SUPPLIED BY THE USER.  THE VARIABLE NAME              */
/* 'TITLE' IS A CHARACTER STRING OF 50 CHARACTERS AND APPEARS AT THE */
/* TOP OF THE MAP.  ITS INTENDED PURPOSE IS TO DESIGNATE THE NAME OF */
/* THE VARIABLE BEING MAPPED OR THE PROJECT TITLE.  THE VARIABLE             */
/* NAME 'LABEL IS ALSO A CHARACTER STRING CONTAINING A MAXIMUM OF 50 */
/* CHARACTERS.  IT APPEARS DIRECTLY BELOW THE MAP  AND MAY BE USED           */
/* TO IDENTIFY THE  DATA  BEING MAPPED.  THE NAME 'LEG(*)' IS AN             */
/* ARRAY OF TEN CHARACTER STRINGS EACH 50 CHARACTERS LONG.  EACH             */
/* VARIABLE.  EACH VARIABLE BEING MAPPED IS ASSIGNED A VALUE BETWEEN */
/* 1 AND 10 WHICH CORRESPONDS TO  THE LEG ELEMENT (LEG(1), LEG(2)).          */
/* IF LESS THEN 10 ATTRIBUTES ARE USED THEN THE UNUSED ELEMENTS              */
/* MUST BE A BLANK ENCLOSED AS SINGLE QUOTATION MARKS SUCH AS:               */
/*              LEG(10) = ' ';                                               */
/* THE VARIABLE NAME 'LINE(*)' IS A 5 ELEMENT ARRAY THAT PERMITS             */
/* THE USER TO PROVIDE  UP TO 5 LINES OF SPECIAL INFORMATION OR              */
/* PROJECT IDENTIFICATION ON THE COMPUTER PRINTOUT.  IF THE USER             */
/* DOES NOT WISH TO MAKE USE OF THE LINE OPTION HE MUST INSERT A             */
/* CARD WITH THE FOLLOWING STATEMENT:                                        */
/*              LINE(1) =' ';                                                */
/*                                                                           */
DCL (IMAX, JMAX) FIXED BIN;
DCL (AXIS, JAXIS, INCREMENT) FIXED BIN;
DCL (TITLE, LABEL, LEG(10)) CHAR(50);
DCL LINE(5) CHAR(100);
/***************************************************************************

/* USER CARDS FOLLOW */

IMAX =
JMAX =

IAXIS =
JAXIS =              /* USER SUPPLIED INFORMATION */
```

```
INCREMENT =
CELL_NUMB =
TITLE =
LABEL(*) =
LINE(*) =

/*************************************************************************/

BEGIN;
OPEN FILE (SYSPRINT) PAGESIZE(88);
   DCL (X, Y) FIXED BIN;
DCL ATTR FIXED BIN;
DCL REMAP(IMAX,JMAX) FIXED BIN INITIAL ((IMAX*JMAX)0);
   DCL (IROW, JCOL) FIXED BIN;
   DCL (ROW(IMAX), COL(JMAX)) FIXED BIN;
DCL FREQ(10) FIXED BIN INITIAL((10)0);
ON ENDFILE (SYSIN) GO TO MAP;

   IROW = IAXIS;
        I=I;
SEARCH: GET EDIT (X) (COL(1), F(4));
  SEEK: IF X = IROW THEN GO TO HUNT;
        IROW = IROW + INCREMENT;
        I = I + 1;
        GO TO SEEK;
  HUNT: JCOL = JAXIS;
           GET EDIT(Y) (COL(6), F(4));
           DO J = 1 TO JMAX;
              IF Y ¬= JCOL THEN
                 JCOL = JCOL + INCREMENT;
                 ELSE GO TO FOUND;
              END;
FOUND: GET EDIT (ATTR) (F(2));
       REMAP(I,J) = ATTR;
       FREQ(ATTR) = FREQ(ATTR) + 1;
       GO TO SEARCH;
   MAP: IROW = IAXIS;
        JCOL = JAXIS;
   DO I = 1 TO IMAX;
      ROW(I) = IROW;
      IROW = IROW + INCREMENT;
      END;
   DO J = 1 TO JMAX;
      COL(J) = JCOL;
      JCOL = JCOL + INCREMENT;
      END;

/* INFORMATION IS TRANSLATED INTO CHARACTER SETS AND OUTPUTTED IN     */
/* THE MAP FORMAT.                                                     */
DCL SYM(10) CHAR(1);
   SYM(1)='.';
   SYM(2)='|';
   SYM(3)='-';
   SYM(4)='+';
   SYM(5)='X';
   SYM(6)='0';
   SYM(7)='=';
```

```
   SYM(8)='|';
   SYM(9)='X';
   SYM(10)='#';

/* ARRAY(*,*) IS A TEMPORARY STORAGE SPACE WHICH IS USED TO PRINT     */
/* THE COLUMN REFERENCE NUMBERS VERTICALLY.                            */

DCL ARRAY(4,JMAX) FIXED BIN INITIAL ((4*JMAX)0);
   DCL (ITEMP, NFIX(4)) FIXED BIN;
      DO N = 1 TO JMAX BY 2;
             ITEMP = COL(N);
             DO I = 1 TO 3;
                  NFIX(I) = ITEMP/10**(4-I);
                  ITEMP = ITEMP-(NFIX(I)*10**(4-I));
                  ARRAY(I,N) = NFIX(I);
                  END;
             ARRAY(4,N) = ITEMP;
             END;

/* BEGIN PRINTING MAP                                                  */

      PUT EDIT(TITLE) (A(50));
   PUT SKIP;
   DO M = 1 TO 4;
      PUT SKIP EDIT (' ') (COL(6), A(1));
        DO N = 1 TO JMAX BY 2;
         PUT EDIT (ARRAY(M,N)) (F(2));
         END;
      END;
      PUT EDIT (('*' DO I = 6 TO JMAX + 9)) (COL(I), A(1));
      PUT EDIT ('*', '*') (COL(6), A(1), COL(JMAX+9), A(1));
      DO I = 1 TO IMAX;
         PUT EDIT (ROW (I), '*') (COL(1), F(4), X(1), A(1));
         DO J = 1 TO JMAX;
            IF REMAP(I,J) > 5 THEN DO;
               PUT EDIT (SYM(6)) (COL(J+7), A(1));
               END;
            DO N = 1 TO 5;
               IF REMAP(I,J) = N THEN DO;
                  PUT EDIT (SYM(N)) (COL(J+7), A(1));
                  END;
               END;
            END;
         PUT SKIP(0);
         DO N = 7 TO 10;
            DO J = 1 TO JMAX;
               IF REMAP(I,J) >= N THEN DO;
                  PUT EDIT (SYM(N)) (COL(J+7), A(1));
                  END;
               END;
            PUT SKIP(0);
            END;
         PUT EDIT (' * ', ROW(I)) (COL(JMAX+8), A(3), F(4));
         END;      /* I LOOP  */
      PUT EDIT ('*', '*') (COL(6), A(1), COL(JMAX+9), A(1));
      PUT EDIT (('*' DO I = 6 TO JMAX + 9)) (COL(I), A(1));
    DO M = 1 TO 4;
```

```
      PUT SKIP EDIT (' ') (COL(6), A(1));
        DO N = 1 TO JMAX BY 2;
         PUT EDIT (ARRAY(M,N)) (F(2));
         END;
      END;
   PUT SKIP(2) EDIT (LABEL) (A(50));
   PUT SKIP(2);
   IF LINE(1) ¬= ' ' THEN DO;
      PUT EDIT (LINE(1)) (A(100));
      DO N = 2 TO 5;
         PUT EDIT (LINE(N)) (COL(50), A(50));
         END;
      END;
   PUT SKIP(3) EDIT ('LEGEND') (COL(53), A(50));
   DO N = 1 TO 10;
      IF LEG(N) ¬= ' ' THEN DO;
         PUT EDIT (N, ' = ', LEG(N)) (COL(50), F(2), A(3), A(50));
         END;
      END;
   PUT SKIP(3) EDIT ('FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EAC
H LEVEL') (A(100));
   PUT SKIP(2) EDIT ('LEVELS       0') (X(1), A(14));
   DO NLEVEL = 1 TO 10;
     PUT EDIT (NLEVEL) (X(8), F(2));
     END;
   PUT SKIP(1);
   PUT EDIT (('=' DO I = 10 TO 120)) (COL(I), A(1));


   DO N = 1 TO 5;
      IF N = 3 THEN
      DO;
        PUT SKIP EDIT ('SYMBOLS') (X(1), A(7));
        END;
     ELSE DO;
        PUT SKIP;
        END;
     PUT EDIT ('......... ||||||||| --------- +++++++++ XXXXXXXX 00000
0000 000000000 000000000 000000000 000000000') (COL(21), A(100));
     PUT SKIP (0);
     PUT EDIT ('========= ========= ========= =========') (COL(81),
        A(40));
     PUT SKIP (0);
     PUT EDIT ('||||||||| ||||||||| |||||||||') (COL(91), A(30));
     PUT SKIP (0);
     PUT EDIT ('XXXXXXXXX XXXXXXXXX') (COL (101), A(20));
     PUT SKIP (0);
     PUT EDIT ('#########') (COL(111), A(10));
     END;
   PUT SKIP;
   PUT EDIT (('=' DO I = 10 TO 120)) (COL(I), A(1));
   TOT = 0;
   DO N = 1 TO 10;
        TOT = FREQ(N) + TOT;
        END;
   NZILCH = (JMAX*IMAX)-TOT;
   PUT EDIT ('FREQUENCY', NZILCH) (COL(2), A(9), F(6));
```

```
   DO N = 1 TO 10;
        PUT EDIT (FREQ(N)) (X(4), F(6));
        END;
   END;     /* END BEGIN BLOCK  */
END MAP3;
```

```
MAP4: PROCEDURE OPTIONS (MAIN);

/* ERP - MAP4                BY THOMAS M. KUNTZ                                */
/*                              DEPT. OF REGIONAL AND COMMUNITY PLANNING        */
/*                              KANSAS STATE UNIVERSITY                         */
/***************************************************************************/
/*                                                                          */
/*     MAP4 IS A SPECIALIZED PROGRAM OF THE ERP PACKAGE.  IT IS            */
/* DESIGNED TO MAP RESOURCE DATA EXTRACTED ACCORDING TO THE NUMBER         */
/* OF OCCURENCES PER CELL.  AS MANY AS 35 ATTRIBUTES OF A VARIABLE         */
/* MAY BE MAPPED.  THE PROGRAM WILL ONLY ACCEPT INTEGER VALUES             */
/* BETWEEN 1 AND 10.  THE PROGRAM WILL PRODUCE A SET OF SPATIALLY          */
/* RELATED, TWO-DIMENSIONAL MAPS (ONE FOR EACH ATTRIBUTE) ILLUSTRAT-       */
/* ING THE DENSITY PATTERN OF EACH RESOURCE AND THE FREQUENCY              */
/* DISTRIBUTION FOR EACH VALUE.  THE FOLLOWING CARDS ARE REQUIRED          */
/* BY THE USER TO ESTABLISH THE BOUNDARIES OF THE SITE.                    */
/*              IMAX = (NUMBER OF ROWS);                                    */
/*              JMAX = (NUMBER OF COLUMNS);                                 */
/*              KMAX = (NUMBER OF ATTRIBUTES);                              */
/* THE USER MUST ALSO PROVIDE THE REFERENCE NUMBER OF UPPER LEFT           */
/* CELL.(NOTE - THIS CELL MUST HAVE THE LOWEST ROW AND COLUMN VALUE).*/
/* THE USER MUST ALSO PROVIDE THE INCREMENTAL DIFFERENCE  BETWEEN          */
/* GRID LINES.                                                              */
/*              IAXIS = (ROW NUMBER OF UPPER LEFT CELL);                    */
/*              JAXIS = (COLUMN NUMBER OF UPPER LEFT CELL);                 */
/*              INCREMENT = (INCREMENTAL DIFF. BETWEEN GRID LINES);         */
/*                                                                          */
/*        ADDITIONAL CARDS FOR PRINTING OUT APPROPRIATE LABELS MUST        */
/* ALSO BE SUPPLIED BY THE USER.  THE VARIABLE NAME 'TITLE' IS A           */
/* CHARACTER STRING OF 50 CHARACTERS USED TO IDENTIFY THE VARIABLE         */
/* NAME.  'LABEL(*)' IS A VARIABLE NAME  DESCRIBING THE SPECIFIC           */
/* ATTRIBUTE OF THE VARIABLE BEING MAPPED.  THERE IS ONE LABEL FOR         */
/* EACH ATTRIBUTE.  THE MAXIMUM LENGTH IS 100 CHARACTERS.                  */
/* THE USER CARD SHOULD FOLLOW THE FORMAT BELOW:                           */
/*              TITLE = 'NAME OF VARIABLE';                                 */
/*              LABEL(*) = 'NAME OF ATTRIBUTE';                             */
/* THE ASTERISK (*) REPRESENTS THE SEQUENTIAL NUMBER OF EACH               */
/* ATTRIBUTE.                                                               */
/*      THE USER MAY ALSO USE UP TO FIVE LINES ON THE COMPUTER             */
/* PRINTOUT TO PROVIDE INFORMATION PERTINENT TO HIS SPECIAL PROJECT        */
/* OR STUDY.  THE FIRST LINE MAY CONTAIN UP TO 100 CHARACTERS AND          */
/* THE REMAINING FOUR LINES CONTAIN 50 CHARACTERS EACH.  IF THE USER       */
/* DOES NOT WISH TO USE THE LINE OPTION HE MUST USE THE STATEMENT:         */
/*              LINE(1) = ' ';                                              */
/*                                                                          */
/***************************************************************************/
DCL (IMAX, JMAX, KMAX) FIXED BIN;
DCL (IAXIS, JAXIS, INCREMENT) FIXED BIN;
DCL TITLE CHAR(50);
DCL LABEL(35) CHAR(100);
/***************************************************************************/

/* USER CARDS FOLLOW */

IMAX =
JMAX =
KMAX =
```

```
IAXIS =
JAXIS =             /* USER SUPPLIED INFORMATION */
INCREMENT =
TITLE =
LABEL(*) =
LINE(*) =

BEGIN;
OPEN FILE (SYSPRINT) PAGESIZE(88);
   DCL (X, Y) FIXED BIN;
   DCL ATTR(KMAX) FIXED BIN;
   DCL REMAP(IMAX, JMAX, KMAX) FIXED BIN INITIAL((IMAX*JMAX*KMAX)0);
   DCL (IROW, JCOL) FIXED BIN;
   DCL (ROW(IMAX), COL(JMAX)) FIXED BIN;
DCL FREQ(KMAX,10) FIXED BIN INITIAL ((KMAX*10)0);
ON ENDFILE (SYSIN) GO TO MAP;

   IROW = IAXIS;
        I=1;
SEARCH: GET EDIT (X) (COL(I), F(4));
  SEEK: IF X = IROW THEN GO TO HUNT;
        IROW = IROW + INCREMENT;
        I = I + 1;
        GO TO SEEK;
  HUNT: JCOL = JAXIS;
            GET EDIT(Y) (COL(6), F(4));
            DO J = 1 TO JMAX;
                IF Y ¬= JCOL THEN
                   JCOL = JCOL + INCREMENT;
                   ELSE GO TO FOUND;
                END;
FOUND:          DO K = 1 TO KMAX;
                   GET EDIT (ATTR(K)) (F(2));
                   REMAP(I,J,K) = ATTR(K);
                  FREQ(ATTR(K)) =FREQ(ATTR(K))+1;
                   END;
   GO TO SEARCH;
   MAP: IROW = IAXIS;
        JCOL = JAXIS;
   DO I = 1 TO IMAX;
      ROW(I) = IROW;
      IROW = IROW + INCREMENT;
      END;
   DO J = 1 TO JMAX;
      COL(J) = JCOL;
      JCOL = JCOL + INCREMENT;
      END;

/* INFORMATION IS TRANSLATED INTO CHARACTER SETS AND OUTPUTTED IN      *
/* THE MAP FORMAT.                                                     *
DCL SYM(10) CHAR(1);
   SYM(1)='.';
   SYM(2)='|';
   SYM(3)='-';
   SYM(4)='+';
   SYM(5)='X';
   SYM(6)='O';
```

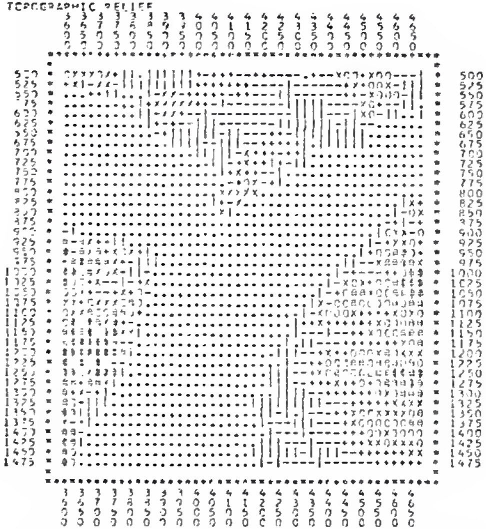
```
   SYM(7)='=';
   SYM(8)='[';
   SYM(9)='X';
   SYM(10)='#';
DCL ARRAY(4,JMAX) FIXED BIN INITIAL ((4*JMAX)0);
DCL (ITEMP, NFIX(4) FIXED BIN;
      DO N = 1 TO JMAX BY 2;
               ITEMP = COL(N);
               DC I = 1 TO 3;
                     NFIX(I) = ITEMP/10**(4-I);
                     ITEMP = ITEMP-(NFIX(I)*10**(4-I));
                     ARRAY(I,N) = NFIX(I);
                     END;
               ARRAY(4,N) = ITEMP;
               END;

/* BEGIN PRINTING MAP
   DO K = 1 TO KMAX;

      PUT EDIT(TITLE) (A(50));
   PUT SKIP;
   DO M = 1 TC 4;
      PUT SKIP EDIT (' ') (COL(6), A(1));
        DO N = 1 TO JMAX BY 2;
         PUT EDIT (ARRAY(M,N)) (F(2));
         END;
      END;
      PUT EDIT (('*' DO I = 6 TO JMAX + 9)) (COL(I), A(1));
      PUT EDIT ('*', '*') (COL(6), A(1), COL(JMAX+9), A(1));
      DO I = 1 TC IMAX;
         PUT EDIT (ROW (I), '*') (CCL(1), F(4), X(1), A(1));
         DO J = 1 TO JMAX;
             IF REMAP(I,J,K) > 5 THEN DO;
                 PUT EDIT (SYM(6)) (COL(J+7), A(1));
                 END;
             DO N = 1 TO 5;
                 IF REMAP(I,J,K) = N THEN DO;
                     PUT EDIT (SYM(N)) (COL(J+7), A(1));
                     END;
                 END;
             END;
         PUT SKIP(0);
         DO N = 7 TO 10;
             DC J = 1 TO JMAX;
                 IF REMAP(I,J,K) >= N THEN DO;
                     PUT EDIT (SYM(N)) (COL(J+7), A(1));
                     END;
                 END;
             PUT SKIP(0);
             END;
         PUT EDIT (' * ', ROW(I)) (COL(JMAX+8), A(3), F(4));
         END;      /* I LOOP  */
      PUT EDIT ('*', '*') (COL(6), A(1), COL(JMAX+9), A(1));
      PUT EDIT (('*' DO I = 6 TO JMAX + 9)) (COL(I), A(1));
    DC M = 1 TO 4;
      PUT SKIP EDIT (' ') (COL(6), A(1));
        DO N = 1 TC JMAX BY 2;
```

```
          PUT EDIT (ARRAY(M,N)) (F(2));
          END;
          END;
        END;
    PUT SKIP(2) EDIT (LABEL(K)) (A(50));
    PUT SKIP(2);
    IF LINE(1) ¬= ' ' THEN DO;
        PUT EDIT (LINE(1)) (A(100));
        DO N = 2 TO 5;
          PUT EDIT (LINE(N)) (COL(50), A(50));
          END;
        END;
    PUT SKIP(3) EDIT ('FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EA
H LEVEL') (A(100));
    PUT SKIP(2) EDIT ('LEVELS        0') (X(1), A(14));
    DO NLEVEL = 1 TO 10;
      PUT EDIT (NLEVEL) (X(8), F(2));
      END;
    PUT SKIP(1);
      IF X = 3 THEN
      DO;
         PUT SKIP EDIT ('SYMBOLS') (X(1), A(7));
         END;
      ELSE DO;
         PUT SKIP;
      PUT EDIT ('......... ||||||||| --------- +++++++++ XXXXXXXXX 0000
0000 000000000 00000CC00 CCCCCCOOO 000000000') (COL(21), A(100));
      PUT SKIP (0);
      PUT EDIT ('========= ========= ========= =========') (COL(81),
         A(40));
      PUT SKIP (0);
      PUT EDIT ('||||||||| ||||||||| |||||||||') (COL(91), A(30));
      PUT SKIP (0);
      PUT EDIT ('XXXXXXXXX XXXXXXXXX') (COL (101), A(20));
      PUT SKIP (0);
      PUT EDIT ('#########') (COL(111), A(10));
      END;
    PUT SKIP;
    PUT EDIT (('=' DO I = 10 TO 120)) (COL(1), A(1));
    TOT = 0;
    DO N = 1 TO 10;
         TOT = FREQ(1) + TOT;
         END;
    NZILCH = (JMAX*IMAX)-TOT;
         PUT EDIT (FREQ(N)) (X(4), F(6));
         END;
    PUT PAGE;
    END;
END MAP4;
```

MAP OUTPUT

PROGRAM: MAP1

TOPOGRAPHIC RELIEF



ELEVATIONAL RELIEF BASED ON CENTROID ELEVATION OF EACH CELL

ENVIRONMENTAL LAND USE PLANNING STUDY

THOMAS M. KUNTZ.
DEPT. OF COMM. & REG. PLNG.
KANSAS STATE UNIVERSITY

DATA MAPPED IN 10 LEVELS FROM THE MINIMUM VALUE 990.00 TO THE HIGHEST VALUE 1390.00

VALUE RANGE APPLYING TO EACH CELL										
MINIMUM	990.00	1030.01	1070.01	1110.01	1150.01	1190.01	1230.01	1270.01	1310.01	1350.01
MAXIMUM	1030.00	1070.00	1110.00	1150.00	1190.00	1230.00	1270.00	1310.00	1350.00	1390.00
PERCENTAGE OF STUDY AREA INCLUDED AT EACH LEVEL	49.77	11.47	11.13	8.80	5.96	6.07	4.09	1.53	0.62	0.51
FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL										
LEVELS	1	2	3	4	5	6	7	8	9	10
SYMBOLS	....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@			
FREQUENCY	876	202	196	155	105	107	72	27	11	9

PROGRAM: MAP2

SLOPE ANALYSIS

TOPOGRAPHIC SLOPE - 7-123

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL										
MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 12.50

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	IIIIIIIII	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	$$$$$$$$$	*********	#########
FREQUENCY	1111	112	43	135	105	88	38	71	34	11	12

PROGRAM: MAP2

SLOPE ANALYSIS

TOPOGRAPHIC SLOPE - 13-20%

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

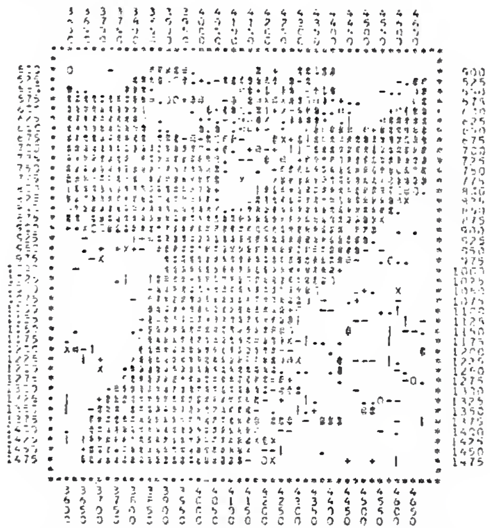
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 9.37

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@			
FREQUENCY	1151	122	56	166	118	60	18	37	18	3	3

PROGRAM: MAP2

SLOPE ANALYSIS



TOPOGRAPHIC SLOPE - 0-2%

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 54.64

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	$$$$$$$$$	[illegible]	[illegible]
FREQUENCY	546	7[illegible]	25	62	45	26	31	42	46	[illegible]	423

SLOPE ANALYSIS

PROGRAM: MAP2

TOPOGRAPHIC SLOPE - 3-65

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 10.93

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	$$$$$$$$$	[illegible]	[illegible]
FREQUENCY	1272	85	26	86	54	60	25	43	43	20	46

PROGRAM: MAP2

SLOPE ANALYSIS

TOPOGRAPHIC SLOPE — 21%+

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

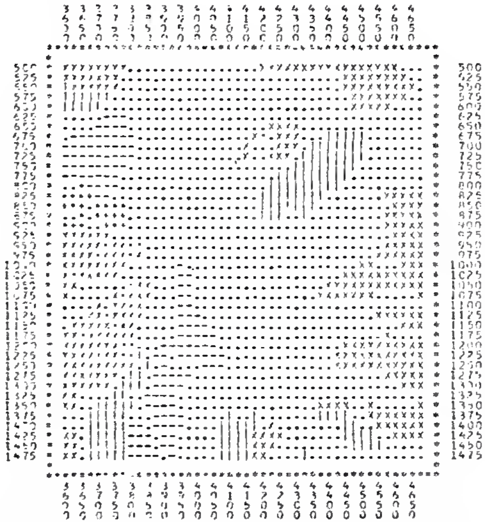
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 9.37

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	[illegible]	[illegible]	[illegible]

PROGRAM: MAP3

PEDOLOGIC ANALYSIS



SOIL STRUCTURE MAP

ENVIRONMENTAL RESOURCE PLANNING STUDY

THOMAS M. KURTZ
DEPT. OF COMM. & REG. PLNG.
KANSAS STATE UNIVERSITY

LEGEND
1 = CLASS 1 - FRIABLE, SILTY, CLAYEY SOILS
2 = CLASS 2 - SANDY SOILS
3 = CLASS 3 - DARK, TIGHT CLAY AND CLAYPAN SOILS
4 = CLASS 4 - LOOSE SANDS
5 = CLASS 5 - SHALLOW, GRAVELLY OR STONY SOILS

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	OOOOOOOOO	@@@@@@@@@	[illegible]	[illegible]	[illegible]
FREQUENCY	2	1084	150	136	23	367	0	0	0	0	0

PROGRAM: MAP2

SOIL STRUCTURE MAP

CLASS 1 - FRIABLE, SILTY, CLAYEY SOILS

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

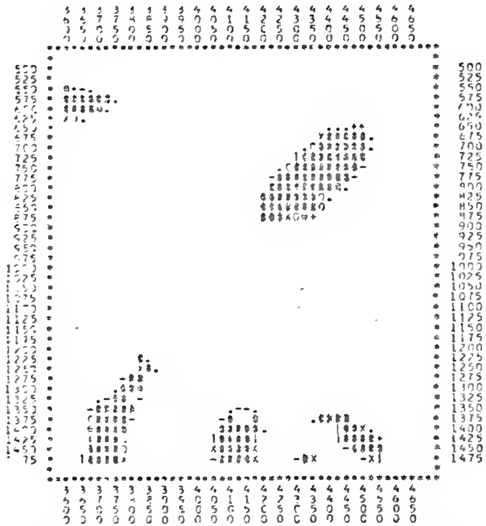
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 60.15

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	[illegible]	[illegible]	[illegible]
FREQUENCY	453	70	24	58	22	42	28	47	40	46	920

PROGRAM: MAP2

SOIL STRUCTURE MAP



CLASS 2 - SANDY SOILS

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

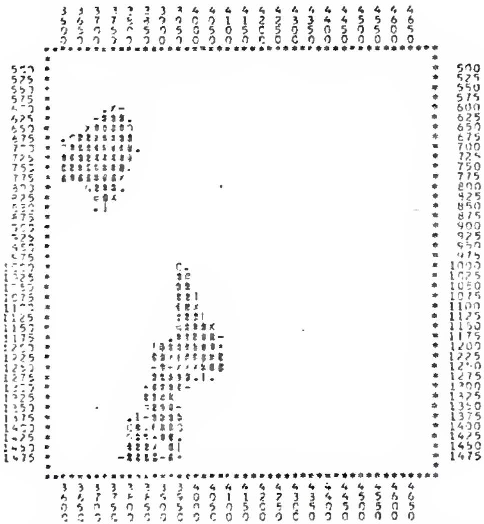
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 7.81

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	IIIIIIIII	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	#########	#########	#########
FREQUENCY	1544	22	7	16	5	11	9	7	9	15	113

PROGRAM: MAP2

SOIL STRUCTURE MAP



CLASS 3 - DARK, TIGHT CLAY AND CLAYPAN SOILS

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

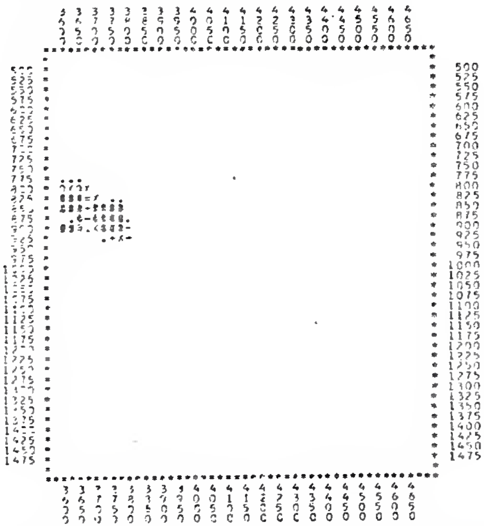
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 7.03

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	IIIIIIIII	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@			
FREQUENCY	1577	14	7	10	4	11	9	4	11	14	99

PROGRAM: MAP2

SOIL STRUCTURE MAP



CLASS 4 - LOOSE SANDS

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

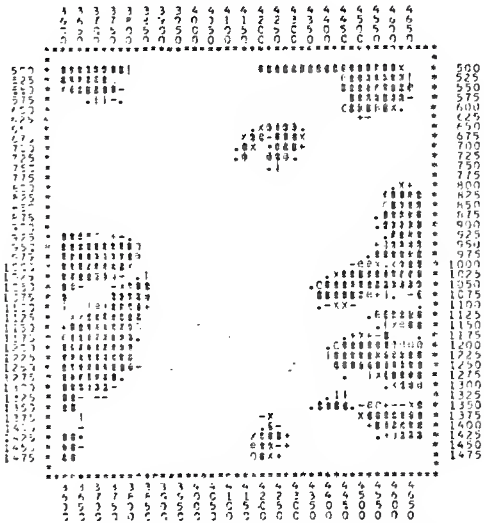
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 0.78

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		·········	IIIIIIIII	---------	+++++++++	XXXXXXXXX	OOOOOOOOO	@@@@@@@@@			
FREQUENCY	1717	9	0	4	1	5	1	3	2	3	15

PROGRAM: MAP2

SOIL STRUCTURE MAP



CLASS 5 - SHALLOW, GRAVELLY OR STONY SOILS

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

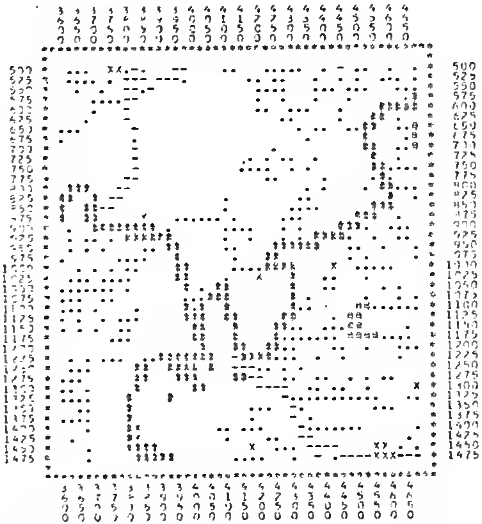
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 20.31

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	ӨӨӨӨӨӨӨӨӨ	[illegible]	[illegible]	[illegible]
FREQUENCY	1265	36	16	27	18	26	11	20	25	31	265

PROGRAM: MAP3

SURFACE DRAINAGE PATTERNS



WATER RESOURCES

ENVIRONMENTAL RESOURCE PLANNING STUDY

THOMAS M. KUNTZ
DEPT. OF COMM. & REG. PLNG.
KANSAS STATE UNIVERSITY

LEGEND
1 = INTERMITTENT STREAM
3 = CREEK
5 = LAKE OR POND LESS THAN 50 ACRES
7 = LAKE OR POND GREATER THAN 50 ACRES
9 = MAJOR RIVER

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		.	|	-	+	X	O	@	[illegible]	[illegible]	[illegible]
FREQUENCY	1131	349	0	57	0	14	0	13	1	15	[illegible]

PROGRAM: MAP2

ANALYSIS OF NATURAL VEGETATIVE COVER

UPLAND FOREST

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

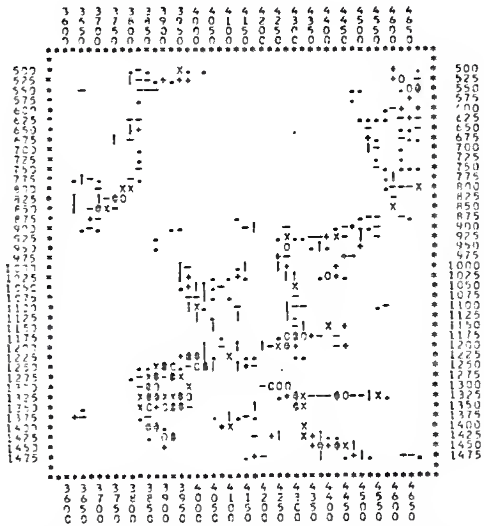
MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 7.03

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	IIIIIIIII	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	[illegible]	[illegible]	[illegible]
FREQUENCY	1404	74	10	80	37	25	37	24	22	24	17

ANALYSIS OF NATURAL VEGETATIVE COVER



PROGRAM: MAP2

LOWLAND FOREST

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL										
MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

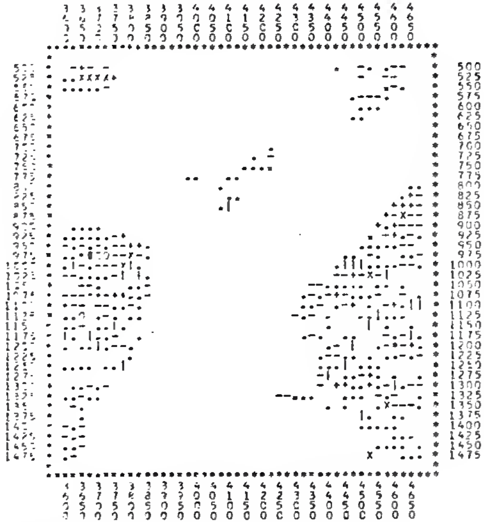
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 3.90

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	OOOOOOOOO	@@@@@@@@@			
FREQUENCY	1435	93	42	79	40	28	18	5	10	6	4

PROGRAM: MAP2

ANALYSIS OF NATURAL VEGETATIVE COVER



SCRUB

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS % PERCENT OF EACH CELL AND
MAPS IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM		0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM		10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 3.12

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	OOOOOOOOO	@@@@@@@@@			
FREQUENCY	1354	221	24	114	29	10	3	0	0	1	0

PROGRAM: MAP2

ANALYSIS OF NATURAL VEGETATIVE COVER

GRASSLAND
ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

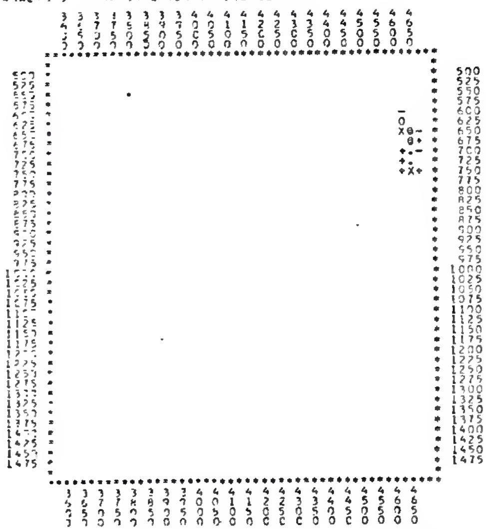
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 15.67

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	IIIIIIIII	---------	+++++++++	XXXXXXXXX	OOOOOOOOO	@@@@@@@@@			
FREQUENCY	1276	50	14	56	38	33	24	46	53	44	126

PROGRAM: MAP2

ANALYSIS OF NATURAL VEGETATIVE COVER



MAP2

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

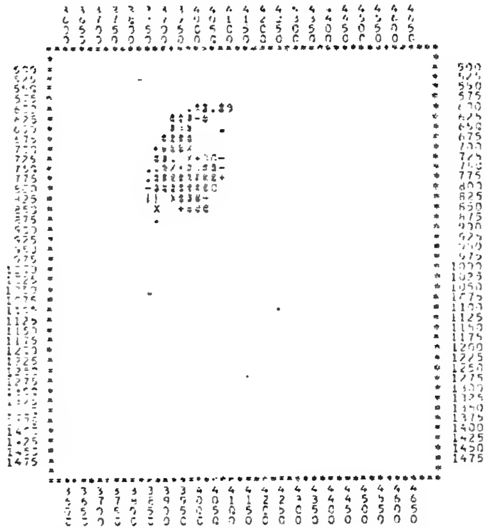
VALUE RANGE APPLYING TO EACH LEVEL										
MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 0.00

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	OOOOOOOOO	@@@@@@@@@	[illegible]	[illegible]	[illegible]
FREQUENCY	1745	2	0	3	5	2	1	2	0	0	0

ACTIVITY PATTERNS



PROGRAM: MAP2

RESIDENTIAL — URBAN

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 2.34

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	ØØØØØØØØØ	ØØØØØØØØØ	$$$$$$$$$	*********
FREQUENCY	1479	14	2	5	6	5	3	6	7	5	29

PROGRAM: MAP2

ACTIVITY PATTERNS

RESIDENTIAL - SUBURBAN

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 11 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL										
MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

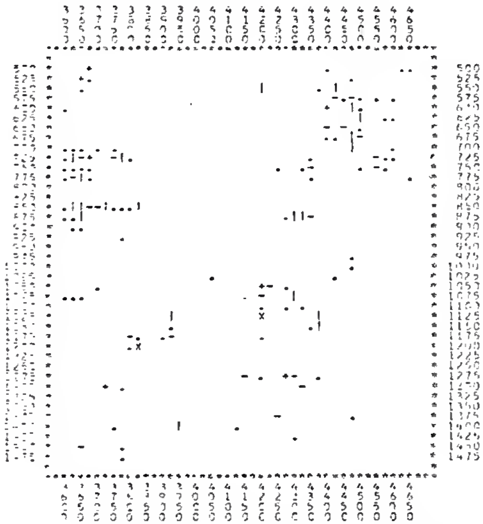
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 3.90

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	IIIIIIIII	---------	+++++++++	XXXXXXXXX	OOOOOOOOO	@@@@@@@@@	#########	$$$$$$$$$	#########
FREQUENCY	1558	41	21	36	27	17	8	13	16	7	16

PROGRAM: MAP2

ACTIVITY PATTERNS



RESIDENTIAL - RURAL

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

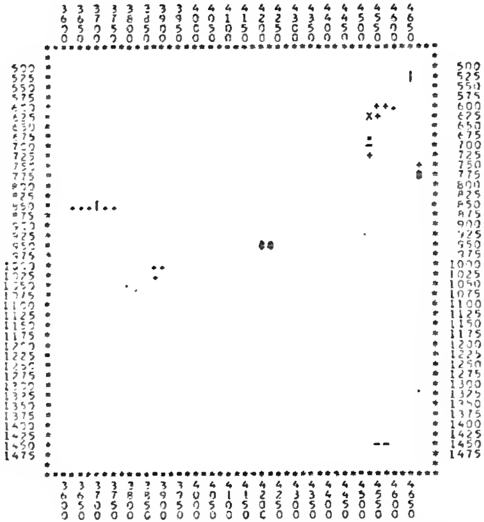
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 0.78

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	[illegible]	[illegible]	[illegible]
FREQUENCY	1629	19	21	23	7	2	0	0	0	0	[illegible]

PROGRAM: MAP2

ACTIVITY PATTERNS



RESIDENTIAL - TRAILER HOMES

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

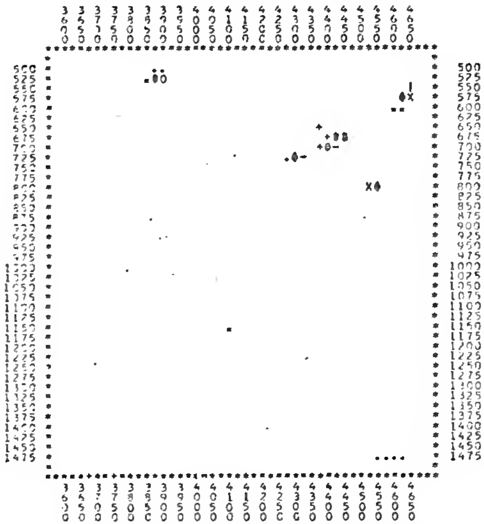
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 0.00

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	$$$$$$$$$	#########	#########
FREQUENCY	1736	10	2	3	5	1	0	1	1	1	0

PROGRAM: MAP2

ACTIVITY PATTERNS



RESIDENTIAL - VACATION

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 0.00

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	IIIIIIIII	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	$$$$$$$$$	$$$$$$$$$	$$$$$$$$$
FREQUENCY	1733	11	1	2	3	2	1	1	4	2	0

PROGRAM: MAP2

ACTIVITY PATTERNS

COMMERCIAL

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL										
MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

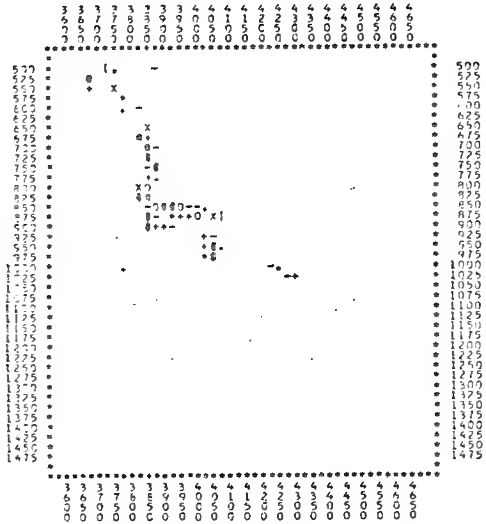
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 1.56

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	[illegible]	[illegible]	[illegible]
FREQUENCY	1668	20	8	20	17	10	5	5	3	2	2

PROGRAM: MAP2

ACTIVITY PATTERNS



INDUSTRIAL

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 0.78

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	[illegible]	[illegible]	[illegible]
FREQUENCY	1705	7	2	12	13	4	4	4	2	2	5

PROGRAM: MAP2

ACTIVITY PATTERNS

AGRICULTURE - CROPLAND

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL										
MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 27.34

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	$$$$$$$$$	#########	#########
FREQUENCY	1003	61	26	60	49	52	20	52	46	90	101

PROGRAM: MAP2

ACTIVITY PATTERNS

AGRICULTURE - GRAZING LAND

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

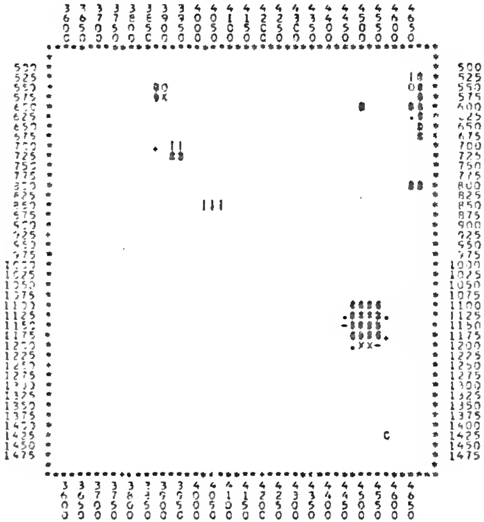
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 30.46

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	[illegible]	[illegible]	[illegible]
FREQUENCY	1083	38	11	21	17	23	14	35	24	50	444

PROGRAM: MAP2

ACTIVITY PATTERNS



RECREATION - STATE AND LOCAL PARK

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

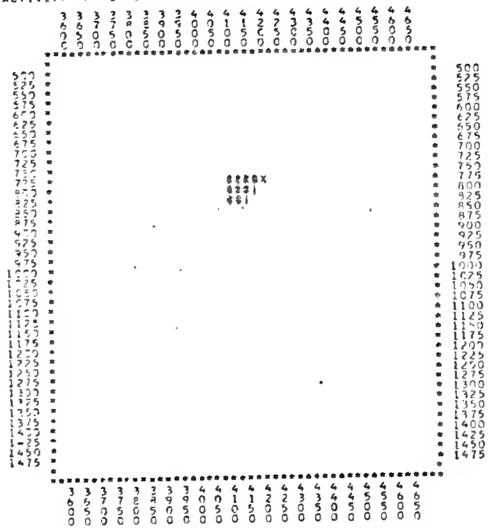
MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 1.56

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	#########	$$$$$$$$$	#########
FREQUENCY	1769	6	6	2	0	3	3	0	1	8	22

ACTIVITY PATTERNS



· PROGRAM: MAP2

RECREATION - GOLF COURSE

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

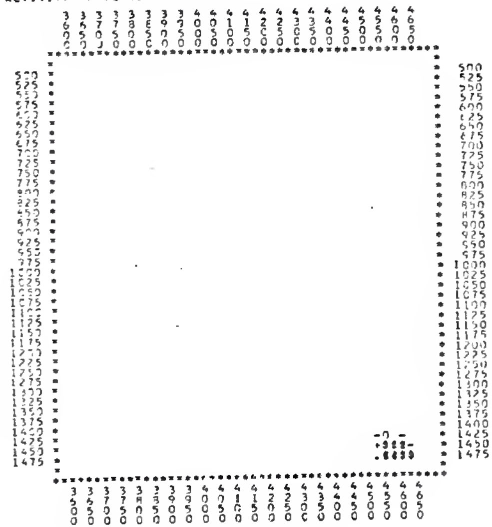
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 0.00

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@			
FREQUENCY	1749	0	2	0	0	1	0	0	2	2	5

PROGRAM: <u>MAP2</u>

ACTIVITY PATTERNS



RECREATION - RIVER OR LAKE ZONING

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL										
MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

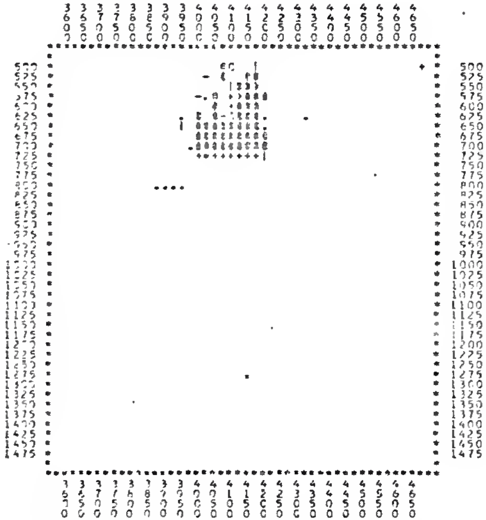
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 0.00

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	[illegible]	[illegible]	[illegible]
FREQUENCY	1747	1	0	3	1	0	1	0	1	2	4

PROGRAM: MAP2

ACTIVITY PATTERNS



INSTITUTIONAL LAND

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00

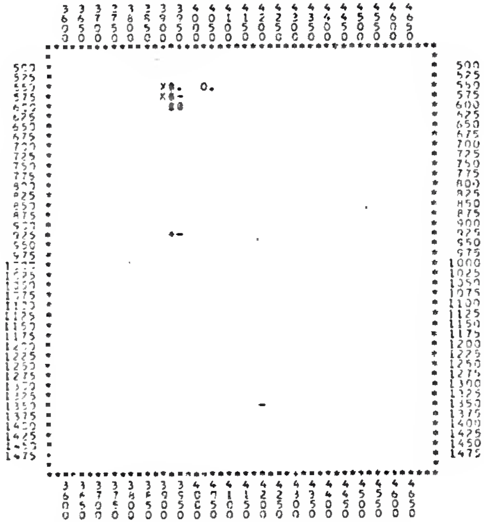
TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 2.34

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@	[illegible]	[illegible]	[illegible]
FREQUENCY	1682	11	4	3	11	1	2	2	5	2	37

PROGRAM: MAP2

ACTIVITY PATTERNS



CEMETARIES

ENVIRONMENTAL LAND USE PLANNING STUDY

TOM KUNTZ
DEPT. OF REG. & COMM. PLANNING
KANSAS STATE UNIVERSITY

DATA IS EXTRACTED AS A PERCENT OF EACH CELL AND
MAPPED IN 10 LEVELS BETWEEN EXTREME VALUES OF 0.00 AND 100.00 PERCENT

VALUE RANGE APPLYING TO EACH LEVEL

MINIMUM	0.01	10.01	20.01	30.01	40.01	50.01	60.01	70.01	80.01	90.01
MAXIMUM	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.10	90.00	100.00

TOTAL PERCENTAGE OF AREA IN WHICH RESOURCE IS PRESENT EQUALS 0.00

FREQUENCY DISTRIBUTION OF DATA CELL VALUES IN EACH LEVEL

LEVELS	0	1	2	3	4	5	6	7	8	9	10
SYMBOLS		....	|||||||||	---------	+++++++++	XXXXXXXXX	000000000	@@@@@@@@@			
FREQUENCY	1747	2	0	3	1	2	1	1	0	0	3

ANALYSIS

The application of a computerized geo-information system to environmental land use planning has several advantages. First, it consolidates information from many sources into a single spatially-related data base. This means the planner, or any potential user of the information, does not have to seek out data from many unrelated sources as has been the traditional approach. Secondly, the data base which has been extracted from maps and aerial photographs of varying scales is displayed in a uniform format, thus enabling the user to analyze the data more readily. Finally, it enables the user to analyze data on a regional scale with a level of discreteness that is virtually impossible with traditional techniques involving overlays.

The computer printout is a graphic display of the data in map form. Each cell is represented by a printed character that is 1/8" x 1/10", thus causing an elongation in the vertical dimension. The user must remember that the data has been extracted on a square-cell basis and that the distortion is only graphic. Further distortion may occur from using the cell system to store linear elements such as highways. Diagonal elements will intersect adjacent cells in such a way that they will appear to deviate from a straight line on the printout. Additional disfiguration will occur as a result of the UTM grid deviating from true north. The problem is related to the selection of cell size. As cell size decreases, a linear feature will more closely approximate its true configuration.

Adjacent to the border of the study area are the four-digit cell identification numbers. A user interested in the data of a particular cell or cluster of cells may readily locate the site by using a U.S.G.S. map keped with the UTM grid lines.

Appearing at the top of the printout is the name of the variable or component of the resource information. Below the map the attribute or specific data description is identified and is followed by the study title. Below the title is a legend which denotes what each particular symbol represents. There are two general categories. In the first case a symbol may represent an attribute and simply indicates that the resource is present within the cell. For example, the map titled "Surface Drainage Patterns," (page 62) intermitent streams are represented by symbol 1, (a period) whereas a major river is represented by symbol 9, (an over printing of an 0, =, 1, and x). In the second case, a symbol may represent a value range for an attribute as is the situation where data is extracted by percent of cell. The value ranges that the symbols represent can be found below the line "Value Range of Each Level." Topographic Relief (page 50) is mapped in 10 levels between the lowest centroid elevation and highest centroid elevation. Data extracted by percent of cell is mapped in 10 levels between 0 and 100 percent. Directly above the symbol block is the percentage of the total site occupied by the resource. The last line on the printout, "Frequency," is a record of the number of occurrences of each symbol.

FURTHER RESEARCH

The geo-information system developed in this study is merely an accounting procedure. Information is extracted from many sources; it is stored in a computer in a spatially relatable manner, and then may be retrieved in the form of a two-dimensional graphic display. Although the system is of great benefit to the land use planner due to the ease of which information may be accessed the system has much greater potential.

The analysis of data contained in the information system through a decision making model is the next logical phase in the development of a computerized geo-information data bank. Such a model would involve the development of a criterion for optimum land use such as proposed by Ian McHarg (McHarg, Twin Cities Study, 1969).

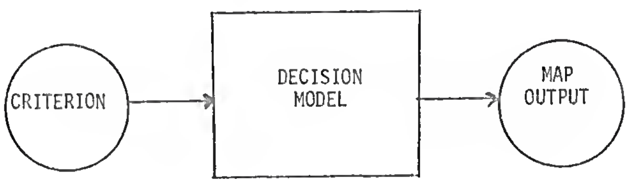


FIGURE 6 DECISION MODEL

The computer procedure would search each cell for the appropriate criterion and then provide a graphic display ranking each cell's suitability for the intended land use. The development of such a model would be appropriate for further application of this study.

Another area for further study is the matter of selecting cell size. Currently the method of selecting an appropriate cell size may be at best described as arbitrary. It would seem that a more scientific system could be developed. Perhaps a method of sampling various cell sizes and performing a statistical test for significant difference could be developed as a supplemental research project.

USER'S
GUIDE

The Computer System

The modern computer is an electronic device capable of manipulating enormous quantities of data and completing numerous mathematical calculations of extreme complexity at tremendous speed. The computer system consists of five basic components. The Central Processing Unit performs the basic mathematical operations and controls the interaction of the other elements in the system. The Compiler is essentially a device for facilitating communication between man and machine. It consists of a set of instructions for translating a Program Language, such as Fortran, PLI, COBAL, etc., into Machine Language. The Memory is the limiting factor in determining how large a problem the computer can handle at one time. The Input and Output devices (often referred to as I/O) make convenient provision for reading data and instructions into the computer and for getting the analysis out. A number of different types of input and output equipment are available. For simplicity, the geo-information system is designed to input data on the Card Reader and output information on the Line Printer. The card reader is the most common input device. There are however, numerous advantages of using other input devices such as Tape or Disk. The user may obtain assistance from the consulting services at the computer center for using either of these two storage modes.

The Punch Card

The punch card has spaces for small rectangular holes organized in 80 columns and 12 rows. These holes are punched on a Key Punch Machine which resembles an electric typewriter and which may be found in any computer center. Information is recorded from right to left

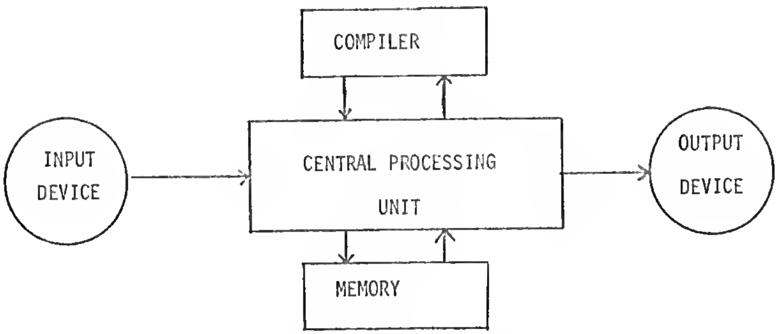


FIGURE 7 BLOCK DIAGRAM OF THE COMPUTER SYSTEM

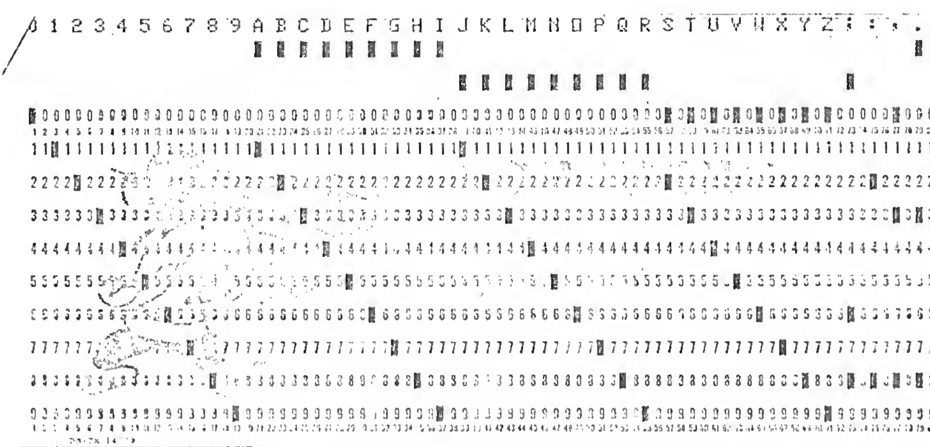


FIGURE 8 THE IBM PUNCH CARD

across the card in the same fashion as information is typewritten across a page. The 80 columns correspond to 80 spaces which 80 numbers, letters, or other symbols may be recorded. Each column has spaces for as many as 12 punches, one in each of the 12 rows. The rows are numbered 0-9 with the 9-row at the bottom of the card, and there are two additional rows (sometimes called the 11 and 12-row) at the top of the card. Numbers are recorded by punching a single hole in one of the 0-9 rows of a given column. Letters and punctuation symbols are recorded by punching two or more holes in a given column. For example, the letter A consists of a punch in the very top row (the 12-row) and in the 1-row, the letter B of a punch in the very top row and in the 2-row, etc. The Card Reader translates these punches into binary coded information reading each column at a time and checking each row to see if there is a punch.

When numerical data are restricted to the positive integers 0-9, any number may be recorded in a single column on the card, and the card may contain as many as 80 different pieces of numerical information. However, many of the numbers we will wish to record on punch cards will be larger than one or may have decimal values. These numbers are recorded by grouping columns together to form fields of the desired width. Thus, a punch card used for numerical data may contain 80 fields of one-column width, 40 fields of two-column width, 16 fields of five-column width, or any combination of fields of varying width as long as the total number does not exceed 80. The field width to be used in the geo-information data bank have been predetermined and are specified in the programming section.

Organizing The Program For Computer Analysis

Each program consists of a set of program decks which must be in the proper sequence for computer analysis. The first deck is a series of Job Control Language (JCL) cards which contain information relating to the execution of the program. The second deck contains a set of user cards in which the user defines the boundaries of the study area and provides certain additional information required for the execution of the program. The third set of cards is the program deck which contains the execution cards and causes the program to process and display information contained in the data bank. This deck is proceeded by another JCL card. The fourth series of cards in the data deck which contains the extracted information relating to a particular variable. It is followed by a final JCL card.

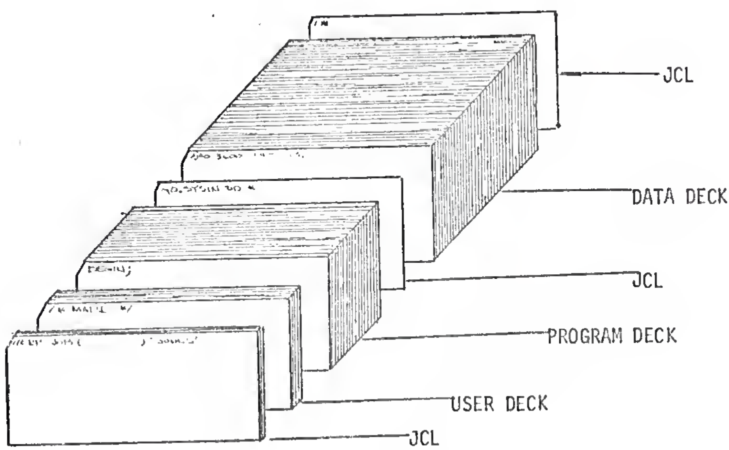


FIGURE 9 ORGANIZATION OF A PROGRAM

Job Control Language

The Job Control Language consists of a set of control cards used to direct the execution of the computer program and to describe the input/output devices used. JCL varies with different systems and computer centers. The following is a description of the JCL statements used for this program. The user may wish to consult a JCL reference guide at this particular computer center for any variations in format.

1. The JOB statement. This is the first card and marks the beginning of a job.

```
//SITEMAP    JOB (    ssn    , acct # ,3,6,,1802,1,,0),'name'
```

The above JOB statement will provide for an output of 6,000 lines printed on white paper at 8 lines per inch.

2. The EXEC (Execute) statement. This card follows the JOB card and names the program or procedure to execute.

```
//ERP        EXEC PL1LFCLG,PARM,PL1L='LINECNT=84'
```

3. The DD (Data Definition) statement. This card describes each data set (in this case a deck of cards) and requests the allocation of I/O devices. This program requires two DD statements. The first card

```
//PL1.SYSIN DD *
```

follows the EXEC statement and the second card

```
//GO.SYSIN DD *
```

precedes the data deck.

4. The Delimiter (/*) statement. This is the "end-of-file" card for marking the end of the data deck.

```
/*
```

It should be noted that all JCL cards (except the /* card) begin with a // in columns 1 and 2, followed by a name field. The words JOB and EXEC begin in column 12.

The User Deck

As previously stated the function of the user deck is to define the boundaries of the site and provide additional information necessary before the execution of the program can begin. The information required for each MAP program will not always be the same, however, the variable names used in each program are constant. The following is a list of the variable names and a description of the type of information required.

Variable Name	Description
IMAX	Integer value, maximum number of rows.
JMAX	Integer value, maximum number of columns.
KMAX	Integer value, maximum number of attributes.
[1]MIN(*)	Integer, array, minimum value of each attribute.
[2]MAX(*)	Integer, array, maximum value of each attribute.
CELL_NUMB	Integer, total number of cells in study area.
[3]IAXIS	Integer, identification number of upper most row.
[3]JAXIS	Integer, identification number of lefthand column.
[3]INCREMENT	Integer, values by which identification number are incremented.
TITLE	Character-string, length 50, name of variable.
LABEL(*)	Character-string, length 100, name of each attribute.
LINE(*)	Character-string, array, length 100, project description, maximum of 5 lines of print.
[2]LEG(*)	Character-string, array, length 50, name of attribute corresponding to coded value, maximum 10.

[1]MAP1 only

[2]MAP3 only

[3]MAP3 and MAP 4 only

The program language used in PL1. It is a versatile language and is well suited to the type of operations performed. For those not familiar with the programing language the following rules are provided to aid in programing the user deck.

1. All statements in the user deck should begin in column 2. Do not use column 1.
2. Do not go past column 72. A statement may be continued on a second card beginning in column 2.
3. Each statement must end with a semi-colon (;).
4. Character-strings must be enclosed with single quotation marks ('character-string').
5. A statement beginning with a /* and ending with an */ is a comment card. This is a nonexecutable statement and is used to aid in documenting the program.

The program documentation for each MAP program specifies the required user cards. The user's attention is called to the statement.

/* USER CARDS FOLLOW */

This is the last statement of the program documentaion and is proceeded by the user cards.

The following examples are provided to illustrate how the user cards for each MAP program are to be punched. Assume for each example that an irregular shaped site is being mapped. The maximum number of cells in a column (IMAX) is 100 and the maximum number of cells in a row (JMAX) is 75 and the total number of cells (CELL_NUMB) is 5350. The upper right hand cell identification number is 100_100 and the values are incremented by 10.

Example 1. The Use of MAP1.

Let us assume we are going to use the MAP1 program to record the resource variable; topographic relief. Three attributes have been extracted from each cell: centroid elevation, lowest elevation, and highest elevation. The table below indicates the minimum and maximum values of each attribute over the entire site.

Attribute	Minimum Value	Maximum Value
(1) Centroid Elevation	900'	1200'
(2) Lowest Elevation	860'	1170'
(3) Highest Elevation	930'	1220'

The program requires the following user cards to be provided.

```
IMAX = 100;
JMAX = 75;
KMAX = 3;
CELL NUMB = 5350
MIN(1) = 900;
MIN(2) = 860;
MIN(3) = 930;
MAX(1) = 1200;
MAX(2) = 1170;
MAX(3) = 1220;
TITLE = 'TOPOGRAPHIC RELIEF';
LABEL(1) = 'ELEVATION MAP BASED ON CENTROID ELEV.';
LABEL(2) = 'ELEVATION MAP BASED ON LOWEST ELEV.';
LABEL(3) = 'ELEVATION MAP BASED ON HIGHEST ELEV.';
```

Additionally, the user is allocated five lines of print to provide information relating to the project. Information such as project title, student name, course name typify information that may be used. The following is an example of the use of this option.

```
LINE(1) = 'ENVIRONMENTAL LAND USE PLANNING STUDY';
LINE(2) = 'JOHN E. DOE';
LINE(3) = 'DEPT. OF LANDSCAPE ARCHITECTURE';
LINE(4) = 'KANSAS STATE UNIVERSITY';
LINE(5) = ' ';
```

Note that if all 5 lines are not used a statement must be included with single quote marks around a blank column. If the user does not wish to use the LINE option he need only insert the statement;

```
LINE(*) = ' ';
```

which will cause the option to default.

The data deck contains the extracted information pertaining to a particular resource variable. Each card is a record containing a cell identification number followed by one or more fields of data. These fields contain the resource information extracted from the cell identified.

The MAP1 program uses a 5-column field width, beginning with column 11, for recording each attribute. The fields are numbered successively and corresponds with the label number. As many as 14 attributes may be recorded on a single data card. A typical data card for data extracted for Example 1 would be punched as:

```
column                 111111111122222222223333333333334
number       1234567890123456789012345678901234567890
             1025 4200  1130  1110  1170
```

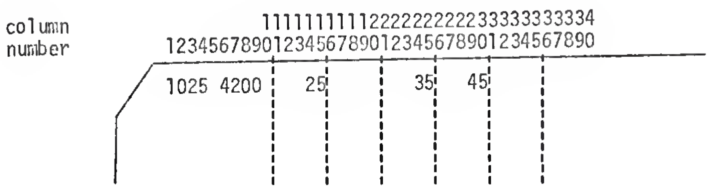
This record tells us that in cell number 1025 4200 the centroid elevation is 1130 feet, the lowest elevation is 1110 feet, and the highest elevation is 1170 feet. MAP1 requires a data card for each cell. If the cell is not included in the study area the fields for the attributes are left blank.

Example 2. The Use of MAP2.

The MAP2 program is utilized with data extracted as a percent of cell. In this example let use assume we are mapping soil types as a resource variable. If five soil classes have been identified and extracted the user cards required are:

```
IMAX = 100;
JMAX = 75;
KMAX = 5;
CELL_NUMB = 5350
TITLE = 'SOIL STRUCTURE MAP';
LABEL(1) = 'CLASS 1 SOILS';
LABEL(2) = 'CLASS 2 SOILS';
LABEL(3) = 'CLASS 3 SOILS';
LABEL(4) = 'CLASS 4 SOILS';
LABEL(5) = 'CLASS 5 SOILS';
LINE(1) - 'ENVIRONMENTAL RESOURCE PLANNING STUDY';
LINE(2) = 'JOHN E. DOE';
LINE(3) = 'DEPARTMENT OF LANDSCAPE ARCHITECTURE';
LINE(4) = 'KANSAS STATE UNIVERSITY';
LINE(5) = '   ';
```

The data cards follow the same format as the MAP1 program. The first 9 columns contain the cell identification number followed by as many as 14 fields of 5-column width beginning in column 11. Each field contains the percent of coverage for each attribute in that cell. The field number corresponds to the LABEL number of each attribute. If the value is punched in the last two columns of each field it is not necessary to punch the decimal point. If no value is recorded in a specified field then the value is assumed to be zero. A typical data card may be punched in the following manner.



The above card indicates that 25% of cell number 1025 4200 is covered by class 1 soil, 0% by class 2 soil, 35% by class 3 soil, 45% by class 4 soil, and 0% by class 5 soil.

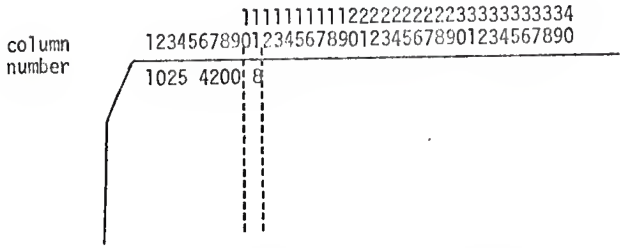
Example 3. The Use of MAP3.

The MAP3 program produces a composite map of attributes extracted on the basis of predominate type or may be used to map data on the basis of occurrence within a cell. To illustrate the use of the program assume that the soil type data had been extracted by predominate type rather than percent of cell as in Example 2. The user cards required for this program will be:

```
IMAX = 100;
JMAX = 75;
IAXIS = 100;
JAXIS = 100;
INCR = 10;
TITLE = 'PEDLOGIC RESOURCER';
LABEL = 'SOIL STRUCTURE MAP';
LEG(1) = '  ';
LEG(2) = 'CLASS 1 SOILS';
LEG(3) = '  ';
LEG(4) = 'CLASS 2 SOILS';
LEG(5) = '  ';
LEG(6) = 'CLASS 3 SOILS';
LEG(7) = '  ';
LEG(8) = 'CLASS 4 SOILS';
LEG(9) = '  ';
LEG(10) = 'CLASS 5 SOILS';
LINE(1) = 'ENVIRONMENTAL LAND USE PLANNING STUDY';
LINE(2) = 'JOHN E. DOE';
LINE(3) = 'DEPARTMENT OF LANDSCAPE ARCH.';
LINE(4) = 'KANSAS STATE UNIVERSITY';
LINE(5) = '  ';
```

Note that there is only one LABEL card for this program. The variable name 'LEG' is used to print out the appropriate legend. Each attribute that is being extracted is assigned a two-digit integer value that corresponds to its position in the LEG array. In this instance class 1 soils are coded as 02, class 2 soils as 04, class 3 soils as 06, class 4 soils are 08, and class 5 soils as 10. The program is limited to mapping ten attributes for each resource variable. Each unused element of the LEG array is represented by a blank column between single quote marks (').

The data cards contain only the cell identification number and the two digit value of the dominate attribute or resource found in the cell. This value is punched in columns 10 and 11. A data card for the cell used in Example 2 would be punched as follows:



The predominant soil type is the class 4 soil which corresponds to the eighth position of the LEG array and is therefore coded 8. Unlike MAP1 and MAP2, MAP3 requires a record of only those cells from which data is extracted or in which the resource being mapped occurs. This feature facilitates extracting data by occurrence of resources which may occupy relatively few cells.

Example 4. The Use of MAP4.

The MAP4 program is used for data extracted according to number per cell. It functions similar to the MAP1 program, however, it does not require a data card for each cell. The program assumes that if a record is not provided for a cell the resource does not occur at that cell location. The program is also limited to recording integer values from 1 to 10. To illustrate the use of the program assume that data relating to transportation systems are to be mapped according to number per cell and the following attributes have been extracted:

1. 4-Lane Divided Highway
2. 2-Lane State Highway
3. County Road
4. Lecal Serving Street
5. Railroad

The following user cards are required.

```
IMAX = 100;
JMAX = 75;
KMAX = 5;
IAXIS = 100;
JAXIS = 100;
INCREMENT = 10;
TITLE = 'TRANSPORTATION ANALYSIS';
LABEL(1) = '4-LANE DIVIDED HIGHWAY';
LABEL(2) = '2-LANE STATE HIGHWAY';
LABEL(3) = 'COUNTY ROAD';
LABEL(4) = 'LOCAL SERVING STREET';
LABEL(5) = 'RAILROAD';
```

The program will produce a set of computer maps, one map for each attribute, which graphically depicts the density of each transportation system.

The data record consists of the cell identification number followed by as many as 35 2-column fields for recording the number of occurrences of each attribute within the cell. The field number of each attribute corresponds to its respective LABEL number. From the above example a cell containing a 4-Lane divided highway and 2 county roads would be punched as follows:

```
column                     1111111111222222222233333333334
number            1234567890123456789012345678901234567890
                  1025 4200 1   2
                           field 1  field 2  field 3  field 4  field 5
```

APPENDICES

APPENDIX A

DATA CLASSIFICATION SUPPLEMENT

The following presents a summary of one classification, and a listing of data as mapped on individual map sets. The mapping codes for each item in the classification are shown. Area data are mapped and recorded as areas; only the point locations of other data are mapped. They are recorded as mileages, types, or numbers of items.

Land Use Classification
(SUMMARY SHEET)

Agriculture
- Areas:
  - At—Orchard, vineyard, horticulture
  - Ac—Cropland and pasture
- Point data:
  - Active farms (f): number
  - Greenhouses (g): number

Forest Land
- Areas:
  - Fb—Brushland
  - Fn—Forest stands
  - Fp—Plantations (10 acres +)

Water Resources
- Areas:
  - Wh—Hudson River
  - Ws—Other rivers and streams (100' +)
  - Wn—Natural ponds and lakes (1 acre +)
  - Wc—Artificial ponds and reservoirs (1 acre +)
- Point data:
  - Natural ponds and lakes (n): number
  - Artificial ponds and reservoirs (c): number
  - Ponds less than 1 acre in size (p): number
  - Lake and reservoir shoreline (l): miles
  - Streams (s): miles
  - Hudson River shoreline (m): miles

Wetlands
- Areas:
  - Wb—Bogs, marshes
  - Wbs—Salt marshes
  - Ww—Wooded swamp

Islands
- Areas:
  - S—Island designation (Used as prefix for land uses occurring on an island

Residential Land Use
- Areas:
  - Rh—High density (50' frontage maximum)
  - Rm—Medium density (50'-100' frontage)
  - Rl—Low density (100' + frontage)
  - Re—Residential estates (larger than 5 acres)
  - Rr—Rural hamlet
- Point data:
  - High-rise apartment buildings (z): number
  - Trailer parks (v): number

Commercial Land Area
- Areas:
  - Cu—Central business district
  - Cc—Shopping center
  - Cs—Commercial development

Industrial Land Area
- Areas:
  - It—Tank farm
  - Ig—Generating station
  - Ic—Cement plant
  - Io—Other manufacturing

Extractive Industry
- Areas:
  - Es—Stone quarries
  - Eg—Sand, gravel, clay, borrow pits

Outdoor Recreation
- Areas:
  - OR—All outdoor recreation facilities
- Point data:
  - Outdoor recreation facilities (OR): types present
    - Golf courses (OR-1)
    - Ski areas and related winter sports (OR-2)
    - Swimming beaches and pools (OR-3)
    - Marinas, yacht clubs (OR-4)
    - Stadium (OR-6)
    - Drive-in theaters (OR-7)
    - Fairgrounds (OR-8)
    - Parks (OR-9)
    - Race tracks (OR-11)
    - Amusement parks (OR-12)
    - Zoo, botanical gardens, museums (OR-14)

Public and Semi-Public Institutional Land Uses
- Areas:
  - P—All areas
- Point data:
  - Public and semi-public areas (P): types present
    - Educational (P-1)
    - Religious (P-2)
    - Health (P-3)
    - Military (P-4)
    - Cemetery (P-6)
    - Water treatment (P-7)
    - Prison and other correctional (P-8)
    - Governmental (P-9)

Sewage and Solid Waste Disposal Facilities
- Areas:
  - D—All areas
- Point data:
  - Sewage and solid waste disposal facilities (D): types present
    - Sewage treatment plant (D-1)
    - Refuse incineration (D-2)

Transportation Land Area
- Areas:
  - Th—Highway interchanges, limited access right-of-way, etc.
  - Tr—Rail yards
  - Ta—Airports
  - Tb—Barge Canal (active)
  - Tp—Port, dock facilities
  - Ts—Shipyards
  - Tl—Locks, dams
  - Tt—Communications and utility facilities
- Point data:
  - Highway category (h): highest present
    - None (h-0)
    - Minor road (h-3)
    - Two-three lane (h-4)
    - Four-lane (h-5)
    - Divided (h-6)
    - Limited access (h-7)
    - Hudson River bridge (h-8)
    - Major interchange (h-9)
  - Railway facilities (Tr): types present
    - Abandoned right-of-way (r-1)
    - Active track (r-2)
    - Stations and structures (r-4)
    - Bridges (r-6)
  - Airport facilities (Ta): types present
    - Personal (a-1)
    - Noncommercial (a-2)
    - Commercial (a-3)
    - Airline (a-4)
    - Military (a-5)
    - Heliport (a-6)
    - Seaplane base (a-7)
  - Utilities (tt): type present
    - Electric power—long-distance transmission (t-1)

Historical Transportation Area
- Areas:
  - Hb—Abandoned Barge Canal

Environmental and Natural Resource Factors
(SUMMARY SHEET)

Soils: predominant type
- S-1 Organic
- S-2 Clay
- S-3 Silt
- S-4 Sand and gravel
- S-5 Till
- S-6 Sand

Depth to bedrock: predominant condition
- B-1 0- 5′
- B-2 6-10′
- B-3 11-20′
- B-4 21′ +

Ground-water table: predominant class
- G-1 High (surface to −10')
- G-2 Low (below −10')

Land forms: types present
- L- 1 Delta
- L- 2 Flood plain
- L- 3 Terrace
- L- 4 Beach lines
- L- 5 Lakebed
- L- 6 Outwash plain
- L- 7 Kames
- L- 8 Eskers
- L- 9 Drumlins
- L-10 Moraine (ground)
- L-11 Escarpments (at least 1 km in length)
- L-12 Hills (local relief less than 700')
- L-13 Mountains (local relief 700' +)
- L-14 Moraine (terminal)

Ridge Lines: presence or absence
- R-0 not present in cell
- R-1 present (extending over 1.5 km)

Edges: presence or absence
- J-0 not present in cell
- J-1 present

Landmarks: types present
- Z-1 Bridges
- Z-2 Chimneys
- Z-3 Towers
- Z-4 Steeples
- Z-5 Gorges
- Z-6 Rock outcrops
- Z-7 Waterfalls

Building height: Dominant height in cell
- H-1 1-2½ stories
- H-2 3-6 stories
- H-3 7 + stories

Building coverage: approximate percentage in cell
- F-1 0-20%
- F-2 21-40%
- F-3 41-60%
- F-4 61-80%
- F-5 81-100%

Paved coverage: approximate percentage in cell
- C-1 0-20%
- C-2 21-40%
- C-3 41-60%
- C-4 61-80%
- C-5 81-100%

Urban areas without trees: predominant condition in cell
- U-0 Not a predominant condition in cell
- U-1 Predominant condition in cell

Shoreline condition
- River shoreline with bulkhead (k): miles
- Land, not currently used, between railroad and river: area
  - Xa—with access
  - X—without access

From Supplemental Maps

Elevation: dominant elevation in cell

- e- 1 0- 500′
- e- 2 500-1000′
- e- 3 1000-1500′
- e- 4 1500-2000′
- e- 5 2000-2500′
- e- 6 2500-3000′
- e- 7 3000-3500′
- e- 8 3500-4000′
- e- 9 4000-4500′
- e-11 4500-5000′
- e-12 5000-5500′

Bedrock: predominant type by physiographic province

- Adirondack Mountains
  - b- 1 Granite-gneiss
  - b- 2 Metamorphosed sediments
  - b- 3 Marble
- Hudson Lowlands
  - b- 4 Shale
  - b- 5 Shale-limestone
  - b- 6 Limestone
- Hudson Highlands
  - b- 7 Metamorphosed igneous
  - b- 8 Gneiss
  - b- 9 Shale
  - b-11 Limestone
- New England Upland
  - b-12 Granite-gneiss
  - b-13 Metamorphics
  - b-14 Marble
- New Jersey Lowlands
  - b-15 Sedimentary
  - b-16 Volcanic sill
  - b-17 Gneiss

Slope: area data (percentage of cell in each class)

- 0- 5%
- 6-15%
- 16-25%
- 25% +

Historic Sites:
number of sites by types

Types are determined by an alphanumeric code consisting of a letter indicating significance and a digit indicating date of origination (e.g., A6, C3, etc.):

- A National importance
- B State importance
- C Local importance
- 1 1609-1644 Dutch Settlement
- 2 1665-1776 English Settlement
- 3 1777-1783 Revolutionary War
- 4 1784-1825 Federal Period
- 5 1826-1916 Industrial Period
- 6 1917-1945 Urbanization
- 7 1946-present Post World War II
- 9 no date indicated

APPENDIX B

NEDECK

```
NEDECK: PROCEDURE OPTIONS (MAIN);
/* NEDECK IS A PROGRAM THAT WILL CONVERT DATA STORED BY PERCENT OF    *
/* CELL TO PREDOMINATE TYPE AND PRODUCE A NEW DATA DECK.              *
        DCL ATTR(14) FIXED DEC (5,2);
        ON ENDFILE (SYSIN) STOP;
ENTER:  GET EDIT (I,J)(COL(1),F(4),X(1),F(4));
        M=1;
        GET EDIT (ATTR(M)) (X(1),F(5,2));
        IF ATTR(M)>=.50 THEN GO TO JUMP;
        DO K = 2 TO 14;
           GET EDIT (ATTR(K)) (F(5,2));
           IF ATTR(K)>ATTR(M) THEN M=K;
           END;
 JUMP:  PUT FILE (SYSPUNCH) EDIT (I,J,M) (COL(1),F(4),X(1),F(4),F(2));
        GO TO ENTER;
        END NEDECK;
```

Selected Bibliography

Data Needs and Data Manipulation, Working Paper 8L, The Institute for Environmental Studies, University of Wisconsin, Madison, National Science Foundation, Research Applied to National Needs, Grant #G-29731, 1972.

Kozlowski, J. and Hughes, J. T., Threshold Analysis, Halsted Press, New York, 1972.

Lynch, Kevin, Site Planning, 2nd edition M.I.T. Press, 1967.

McHarg, Ian L., Design With Nature, Doubleday and Company, New York, 1967.

McHarg, Ian L., An Ecological Study of the Twin Cities Metropolitan Area, June 1969, Unpublished.

Miller, A. H., Remap I: The Application of Computer Technology to Land Use Allocation and Management, Unpublished M. S. Thesis, University of Wisconsin, Madison, 1972.

Niemann, Bernard J. and Miller, Allen H., Minimizing Environmental Impacts From Transportation: An Application of Remote Sensing and Spatial Data Banks. The American Society of Photogrammetry Annual Convention, Washington, D. C.

Neimann, Bernard J. Jr., Handbook: Application of Remote Sensing and Computer Techniques for Recreational Planning Vol. I Summary.

Steinitz, Carl and Rogers, Peter. A Systems Analysis Model of Urbanization and Change: An Experiment in Interdisciplinary Education. Graduate School of Design, Harvard University, Cambridge, Massachusetts, 1968.

Three Approaches to Environmental Resource Analysis, Graduate School of Design, Harvard University, November, 1967.

Miller, A. H. and Neimann, B. J., An Interstate Corridor Selection Process: The Application of Computer Technology to Highway Location Dynamics - Phase I. Environmental Awareness Center, University of Wisconsin, Madison, 1972.

Aerial Phetography as a Planning Tool: Proceedings of the Kodak Seminar. (Eastman Kodad Company, 1974).